



# Supplying next generation scalable microcontrollers

Everything you need on a single chip



Alif delivers the lowest possible power consumption, keeps your data safe, and provides scalable processor selection, all while offering AI/ML acceleration more efficiently than ever before.

The Internet of Things revolution has arrived. Today, we are surrounded by smart, connected devices that help us perform daily tasks, provide useful automation, control and monitor our environment, keep track of where things are located, and more. Smart devices are most useful when they seamlessly integrate into your daily

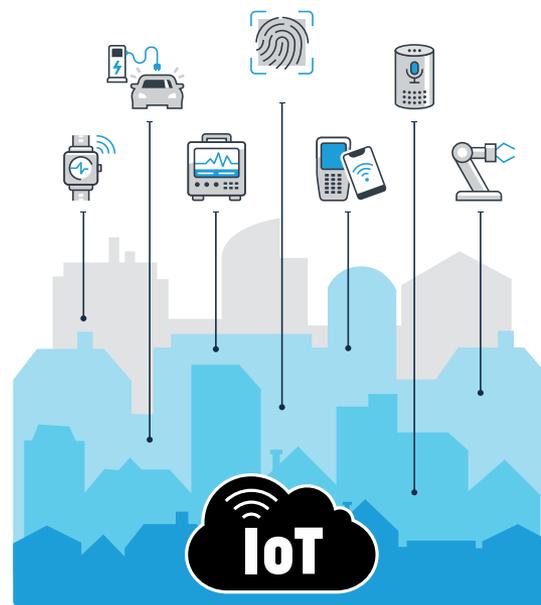
life and routines while performing tasks quickly, correctly, non-intrusively, and maintain a strong level of security to prevent your information, or the device itself from being compromised.

## Closing the gap

Alif Semiconductor™ is the industry-leading supplier of the next-generation Alif Ensemble™ family of microcontrollers and fusion processors.

We were founded with the vision to address the rapidly growing market need for broad, scalable, and connected AI-enabled embedded

computing solutions that are genuinely power efficient. This need led to Alif Semiconductor's creation of a new class of embedded controllers, or fusion processors, that enable seamless integration of technology for everyday life by unlocking innovative low-power techniques, unparalleled functional integration, accelerated AI and ML edge processing, high security, and operating system diversity.



## A modern, revolutionary platform

Alif Semiconductor has developed an innovative technology platform with the range and functional completeness that enables developers to design entire IoT systems using a single chip. This platform, at its core, is built around a scalability concept that allows movement up and down a wide performance continuum as needed. Without requiring architectural changes that force costly software rewrites and migration exercises along the way.

Alif's platform brings scalable, genuinely power-efficient embedded controllers integrated with Artificial Intelligence/Machine Learning (AI/ML) acceleration, multi-layered security, all the required interfaces, and plenty of integrated memory. This allows the enablement of smart IoT devices where processing can be done locally or in the cloud.

### Ensemble Family EMBEDDED PROCESSING



#### HIGHLY SCALABLE FAMILIES OF EMBEDDED CONTROLLERS

The Alif Ensemble™ family is built on the latest generation embedded processing technology that scales from single Arm® Cortex®-M55 microcontrollers (MCUs) to a new class of multi-core devices — fusion processors. These blend up to two Cortex-M55 MCU cores, up to two Cortex-A32 microprocessors (MPU)

cores capable of running high-level operating systems, and up to two Arm Ethos™-U55 microNPUs for AI/ML acceleration. The Alif Ensemble family devices contain an advanced secure enclave that provides multiple layers of security, such as device integrity protection, secure identity and strong root-of-trust, secure life cycle management, and more. Together with large on-chip SRAM and non-volatile memory, accelerated graphics, imaging, and class-leading power characteristics, the Alif Ensemble family is ideal for smart home products, appliances, point-of-sale, robotics applications, and much more.



#### UNRIVALED BATTERY LIFE

Longer product life on a smaller battery



#### SCALABLE PERFORMANCE

Efficient Edge AI processing for any workload



#### NEXT-LEVEL INTEGRATION

Achieve more with fewer components



#### MULTILAYERED SECURITY

Protection at every part of the device life cycle

## aiPM™ technology to extend battery life

Many deployed IoT devices are battery powered, and battery life is critically challenged when there is a high requirement for local processing, and AI/ML.

To address this, Alif Semiconductor is introducing its exclusive aiPM™ technology that essentially powers on only sections of the chip that are needed, when they are needed, and off when they're not. This is based on the immediate processing load-per-use case. This makes even the complex quad-core devices behave like small purpose-built low-power MCUs when they need to, enabling smart IoT devices to run longer on smaller batteries.

## Alif Ensemble™ family features and benefits\*

### FUSION PROCESSORS, A NEW CATEGORY OF EMBEDDED CONTROLLERS

- Fusion processors blend MCU cores, MPU cores, and AI/ML acceleration into a single device.
- Operating system diversity provides the best of both worlds. For example, Linux can run on MPUs for networking and graphics, RTOS can run on MCUs for real time control, while AI/ML inferencing is accelerated in hardware – all simultaneously.
- Alif takes this a step further because device resources (memory, peripherals, interrupts, events, etc.) are assigned and safely shared among these masters based on the developer's choice, not fixed assignments, as products in market have today.
- Devices use a common “fabric” of bus structure, peripherals, firewalls, power management, interrupt handling, etc. that make it easier for Alif to create derivative devices. More importantly, it makes it easier for developers to re-use software from one project to the next.

## The scalable performance of the Alif Ensemble™ family

	Single-Core MCU <b>E1</b>	Dual-Core MCU <b>E3</b>		Triple-Core Fusion Processor <b>E5</b>		Quad-Core Fusion Processor <b>E7</b>	
Real-Time MCU Core	Cortex-M55 160 MHz	Cortex-M55 160 MHz	Cortex-M55 400 MHz	Cortex-M55 160 MHz	Cortex-M55 400 MHz	Cortex-M55 160 MHz	Cortex-M55 400 MHz
MicroNPU AI/ML Accelerator	Ethos-U55 128 MAC/c	Ethos-U55 128 MAC/c	Ethos-U55 256 MAC/c	Ethos-U55 128 MAC/c	Ethos-U55 256 MAC/c	Ethos-U55 128 MAC/c	Ethos-U55 256 MAC/c
Application MPU Core				Cortex-A32 800 MHz		Cortex-A32 800 MHz	Cortex-A32 800 MHz

## SMART POWER MANAGEMENT THROUGH ALIF'S AIPM™ TECHNOLOGY

- aiPM™ technology is a blend of the use of:
  - Several independent smart power domains that can decide to shut down autonomously when there is no activity.
  - Internal power conditioning, sequencing, and regulation, eliminating the need to use an external PMIC (Power Management IC) device.
  - Close connection to the interconnection bus fabric.
  - Software configuration.
- The sum of this essentially powers on only sections of the chip that are needed, when they are needed, and off when they're not depending on immediate processing load-per-use case.

## MEASURED AI/ML PERFORMANCE

*Image Classification, for 1 inference, M-55 + U-55 is:*

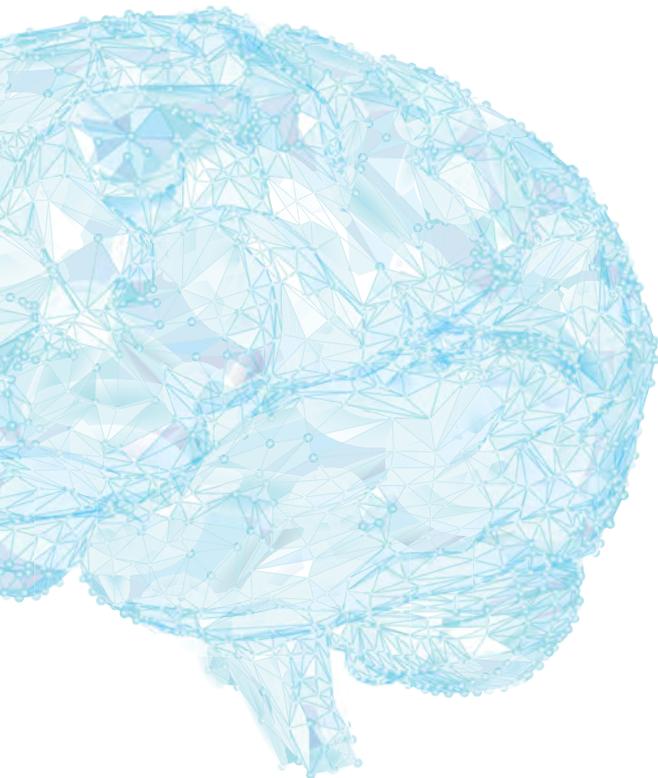
- **800x faster** than previous gen Cortex-M
- **78x faster** than M-55 alone (8 vs 624 msec)
- **76x less energy** than M-55 alone (3 vs 228 mJ)

*MobileNet V2 1.0 Model*

## BEYOND AIPM™ TECHNOLOGY, MORE INTELLIGENT METHODS THAT REDUCE POWER CONSUMPTION

- Multi-core devices are architected in such a way to dedicate the high-efficiency pair of Cortex-M55 MCU/Ethos-U55 NPU to operate at very low power levels while sensing the surroundings (vibration, sound, image, etc.). The high-efficiency Cortex-M55 MCU will then wake up other portions of the device (high-performance Cortex-M55/Ethos-U55, Cortex-A32's, graphics, USB, etc.) in an escalated way as needed to execute the workload based on the immediate use case. aiPM™ technology will take care of shutting them off when no longer needed.

- Power consumption, measured at the device pin while operating at 3.3V:
  - STOP mode, less than 1.0 uA, with Real-Time Clock running and wake sources active.
  - RUN mode, 18 uA/MHz, with Cortex-M55 CPU running code from SRAM.



### KEY AVAILABLE PERIPHERALS, INTERFACES, AND MEMORY

- High speed connectivity: USB-HS, Ethernet 10/100, SDIO.
- Memory expansion: OctalSPI, SD/MMC.
- Display and Graphics: MIPI-DSI, Parallel RGB, 2D Graphic Acceleration.
- Image: MIPI-CSI, Parallel Camera Interface.
- Serial: I3C, I2C, CAN, SPI, UART.
- Audio: PDM, I2S.
- Analog: ADC, DAC, Comparator.
- Memory: Kbytes to Mbytes of on-chip SRAM and Non-Volatile Memory.

### PACKAGES

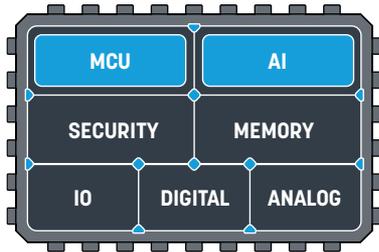
- Very small Wafer Level Chip Scale Packages (WLCSP).
- Dual-Row Quad-Flat No-Leads (DR-QFN) packages for easy circuit board layout.
- Ball grid array packages (BGA)

### FLEXIBLE, INTUITIVE SOFTWARE DEVELOPMENT

- Common chip fabric allows reuse of software engineering resources across multiple end-products.
- Alif's device configuration tool simplifies the start of a new design and reduces coding errors from the beginning.
- Major 3rd party tool chains, debuggers, and software development environments support Alif device families, including support to easily translate and compile popular machine learning frameworks.
- Alif DevKits (development kits) provide a hardware platform for fast prototyping and evaluation.

# Alif Ensemble™ Family: High-performance embedded controllers with diverse abilities.

**SINGLE-CORE  
MICROCONTROLLER**



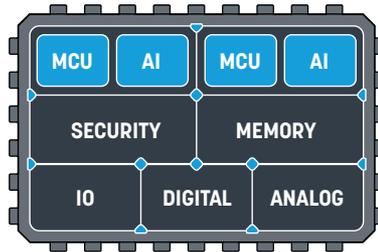
**E1**

Single real-time core with security, AI/ML, imaging, and more.

**APPLICATIONS INCLUDE:**

- Lighting Control
- Smart Homes
- Industrial Sense/Control

**DUAL-CORE  
MICROCONTROLLER**



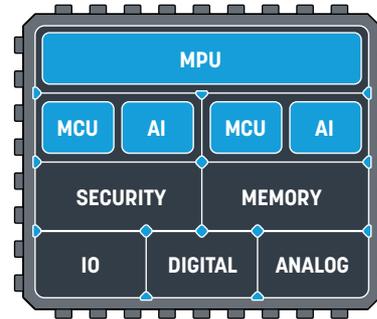
**E3**

Dual real-time cores with security, AI/ML, imaging and more.

**APPLICATIONS INCLUDE:**

- Barcode Scanners
- Failure Prediction
- Portable Healthcare

**TRIPLE-CORE  
FUSION PROCESSOR**



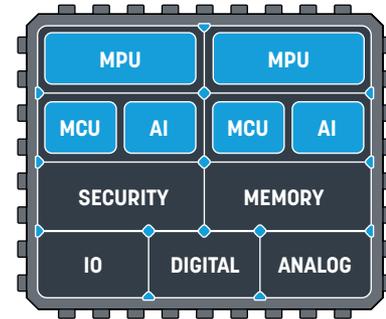
**E5**

Linux-capable single application core, and dual real-time cores with security, AI/ML, imaging, and more.

**APPLICATIONS INCLUDE:**

- Robotics
- Appliances
- Graphical Control Panels

**QUAD-CORE  
FUSION PROCESSOR**



**E7**

Linux-capable dual application cores, and dual real-time cores with security, AI/ML, graphics, imaging, and more.

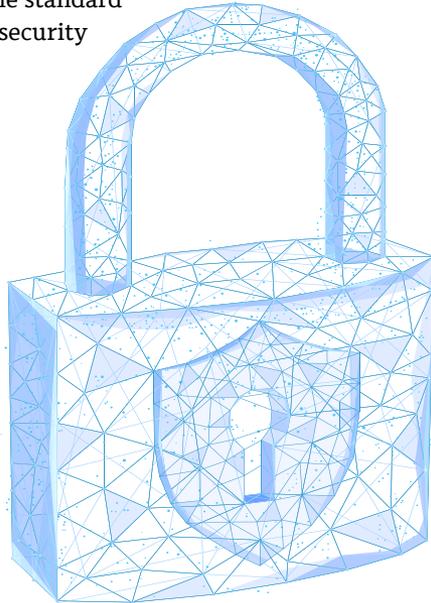
**APPLICATIONS INCLUDE:**

- Building Automation
- EV Recharging Station
- Point-of-Sale Systems

## Alif's Independent Isolated Secure Subsystem

The Alif Ensemble™ family integrates full secure element functionality:

- Root of Trust.
- Unique device ID for each individual chip.
- Dedicated security processor.
- Dedicated protected memory.
- Configurable firewalls that regulate access of each CPU to sections of memories and individual peripherals and extend the capabilities of the standard Arm TrustZone security partitioning.



### MULTILAYERED SECURITY

- Provides multiple layers of defense that protect and restrict access from rogue software attacks, protects secure credentials and provides an additional level of security beyond TrustZone.
- A separate isolated security subsystem, like a Secure Element with its own CPU core and memory, plus immutable secure key storage, and secure cryptographic hardware acceleration.



- Secure boot with signature-based code images.
- Extensive bus fabric firewalls provide low level hardware protection against illegal bus transactions and allows users to restrict access to various chip resources to a given core.
- Device-wide hypervisor functions to manage security policies, secure software updates and coordinates device power management.
- The sum of these security features enable secure life cycle management of an end-product from manufacture through deployment, maintenance, and retirement.
- Developers can choose to use a subset of these security features, but once the features are enabled, they remain in effect through entire life cycle of an end-product.

## Alif Secure Architecture

### ALIF ENSEMBLE™ DEVICES IMPLEMENT A SECURE 4-STAGE LIFECYCLE IN HARDWARE

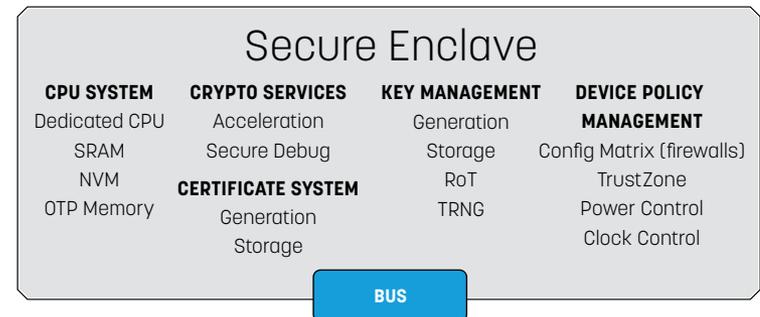
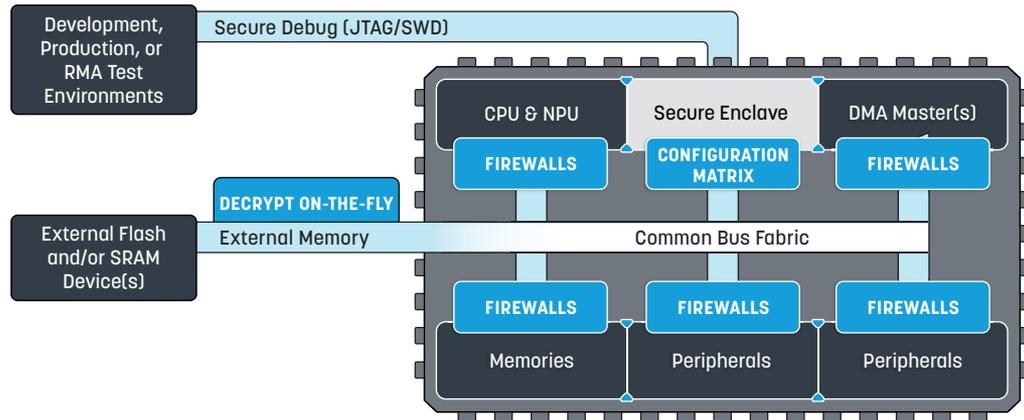
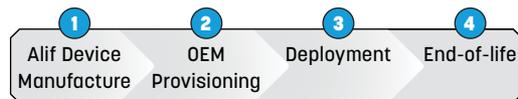
The Ensemble family implements a complete device life-cycle state machine, where all lifecycle stages advance monotonically, preventing rollback attacks.

The initial **Device Manufacture state** is where the unique device ID gets installed by Alif at the factory.

The **Provisioning state** is what is used during development. All parts of the device can be accessed in this state, and changes are reversible.

In the **Deployment state** device security is enabled, and the Alif security sub-system is ready to validate firmware signatures and OTA updates to ensure system integrity.

The **EOL state** is used once the device is to be taken out of commission, which erases all secrets from the device securely.



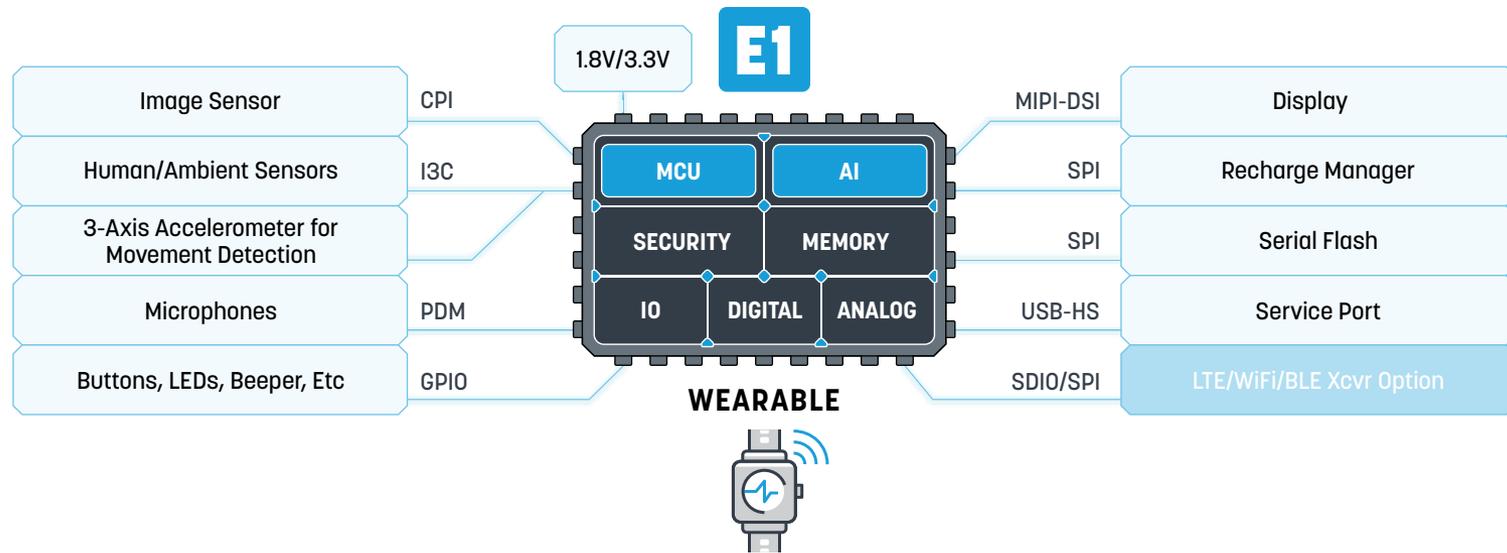
## Solutions By Use Case: Wearables

### SINGLE-CORE MICROCONTROLLER

Amazing performance in a tiny package. The E1 series measures only a few millimeters on each side, but do not let its diminutive size fool you. Inside the E1 series of devices you

will find the very latest advanced integrated functions like dual-lane MIPI-DSI display interface, multiple microphone and audio inputs, fast SAR & 24-bit  $\Delta\Sigma$  ADCs and latest generation sensor interfaces combined with a powerful Cortex-M55 MCU core, a dedicated Ethos microNPU for accelerating ML workloads, and

the lower power consumption of any comparable microcontroller in the market makes E1 series devices the perfect choice for next-generation wearables and MCU-based designs



## Leading-edge, scalable capabilities for development

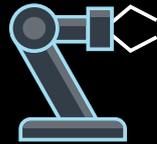
Success in developing and deploying tomorrow's IoT devices depends on access to

the most effective and efficient processing technology. Alif Semiconductor's Ensemble family delivers this technology today,

enabling developers to create smart IoT devices across a wide application spectrum.



**MOBILE POS**



**INDUSTRIAL**



**BIOMETRIC ID**



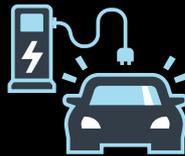
**SMART SPEAKER**



**OBJECT DETECTION**



**CONNECTED  
MEDICAL DEVICES**



**RECHARGE STATION**



**VENDING MACHINE**



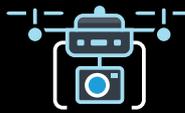
**WEARABLE**



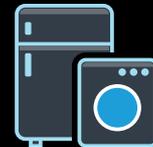
**SMART HOME**



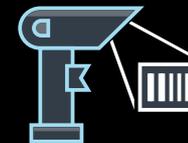
**PROCESS CONTROL**



**DRONE**



**SMART APPLIANCE**



**SCANNER**



**TRAFFIC FLOW**



**Alif Semiconductor™** was founded with the vision to address the rapidly growing market need for broad, scalable and connected AI-enabled embedded computing solutions that are genuinely power efficient. Alif Semiconductor created a new class of embedded controllers – fusion processors – that enable seamless integration of technology for everyday life by unlocking innovative low-power techniques, unparalleled functional integration, accelerated AI and ML edge processing, high security, and operating system diversity.

For more information, **visit [www.alifsemi.com](http://www.alifsemi.com)**.