*Product Overview*

# *TI's TinyEngine™ NPU unlocks edge AI acceleration in more embedded systems*

**Key takeaways**

- Edge AI isn't just for high-end applications. TI microcontrollers (MCUs) with an integrated **TinyEngine neural processing unit (NPU)** enable edge AI in more electronics, from resource-constrained devices - including portable, battery-powered products - to complex industrial applications.
- Embedded system designers can get started faster on AI-enabled designs with access to **TI's free CCStudio™ Edge AI Studio** with 60+ code examples, streamlining development.

## What is the TinyEngine NPU?

The TinyEngine NPU is a proprietary hardware accelerator integrated into TI C2000™ and Arm® Cortex®-based MCUs (Figure 1) that was specifically created to help designers of embedded systems reduce latency and improve energy efficiency when deploying edge AI models at scale.

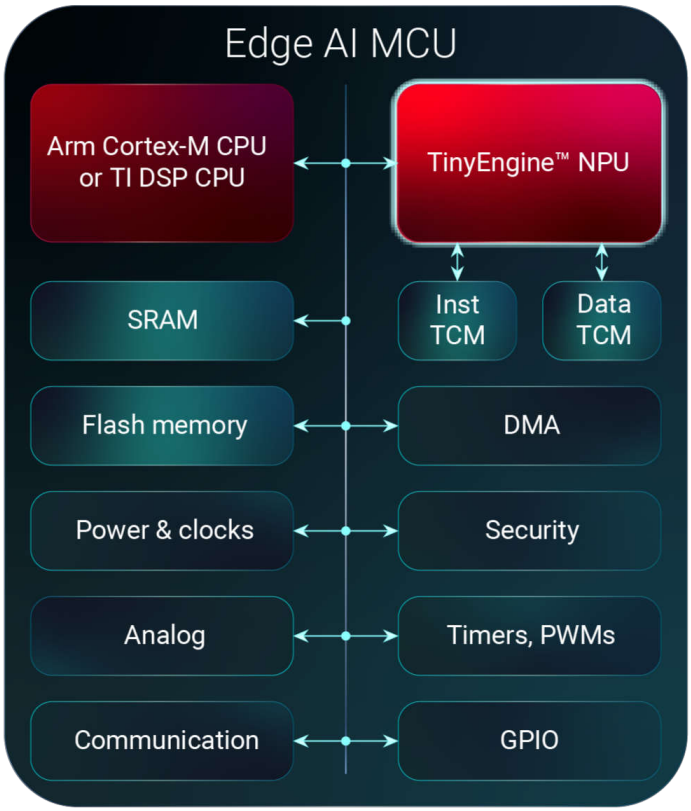


**Figure 1. Simplified Block Diagram of a TI Edge AI MCU with an Integrated TinyEngine NPU**

The TinyEngine NPU executes machine learning algorithms in parallel to the primary CPU, enabling real-time processing of neural network models on resource-constrained devices. This optimizes deep learning inference

operations to reduce latency and power consumption when processing at the edge, eliminating the round-trip latency of cloud-based inferencing for increased system responsiveness.

The NPU helps expand edge AI capabilities into devices that were previously unable to support meaningful AI workloads. This includes battery-powered electronics, medical wearables with real-time insights, personal electronics and industrial equipment.

### Key benefits of the TinyEngine NPU

The TinyEngine NPU addresses key design constraints that have traditionally prevented widespread adoption of embedded AI by delivering:

- **120 times less energy** per inference and **90 times lower latency** compared to software-based AI
- **2.56 GOPS of computation performance** for real-time edge AI inference for deep learning models
- **Support for 8-bit, 4-bit and 2-bit and mixed precision configurations** for quantization and in-place computation to solve memory footprint limitations
- Support for a wide range of neural network layer types like **convolutional layers** (generic, depthwise, pointwise, transposed), **fully connected layers** and **pooling layers** (average and max) with batch normalization
- Less development complexity through **simplified toolchains**, reducing development time **from weeks to hours**

### What TI MCUs feature the TinyEngine NPU?

- TMS320F28P550SJ**:** The NPU in the **TMS320F28P55x series C2000 MCUs** offloads AI inference tasks from the main CPU. For motor drive applications, the NPU enables motor bearing fault detection for predictive maintenance, helping designers identify mechanical degradation early to reduce unplanned downtime and repair costs. For solar and energy storage applications, the NPU supports arc fault detection to identify dangerous electrical faults, improving system safety and reducing false alarms. In both cases, the NPU runs convolutional neural networks locally with five to ten times lower latency than software-only implementations.
- AM13E230x**:** These **Arm Cortex-M33-based MCUs** enable adaptive control and predictive maintenance in appliances, robotics and industrial systems through the integrated NPU and advanced real-time control architecture. This high level of integration enables designers to implement sophisticated motor control and AI features simultaneously without external components while maintaining precise real-time control loops for up to four motors. The NPU runs adaptive control algorithms for load sensing and energy optimization.
- MSPM0G5187**:** These **80MHz Arm Cortex-M0+ based MCUs** are part of TI's MSPM0 MCU family and use the NPU to enable edge AI capabilities in cost-effective, power-optimized electronics. The dedicated hardware NPU executes deep neural network models independently from the main CPU, enabling **90x lower latency** than software implementations and consuming **less than 2µA in standby mode**.

### Getting started with TI's edge AI-enabled MCUs

Designers can get started on their edge AI designs faster with TI's free, royalty-free CCStudio Edge AI Studio, which provides seamless development across TI's entire MCU portfolio including general-purpose, real-time control, wireless connectivity and radar-based MCUs. With CCStudio Edge AI Studio, developers can go from start to finish using an integrated workflow covering data collection and labeling, feature extraction and neural network model selection and tuning, and model compilation and deployment to target hardware.

The platform offers 60+ code examples, application-specific reference designs (arc fault detection, motor fault prediction), and supports industry-standard frameworks like PyTorch, plus no-code designs. Trained models are automatically converted into optimized software libraries without manual coding.

TI's quantization tools and neural network compiler also enable rapid model porting for developers using proprietary AI frameworks, significantly shortening development cycles. These tools also support a wide variety of neural network layers and compatibility with industry-standard trained model formats like ONNX.

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