Application Brief

Growing Need of Processing Technologies in Smart E - Meters

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Energy infrastructure serves as the foundation of modern power systems, enabling smarter grids, improving energy efficiency and facilitating the integration of renewable energy sources. A key component of advanced energy infrastructure is the smart electricity-meter, or e-meter, a device that provides real-time monitoring of energy consumption. Unlike traditional meters, smart e-meters enable two-way communication between consumers and utilities companies, offering enhanced control, accuracy and efficiency in energy usage. These enhanced capabilities require higher processing power. With their ability to measure, analyze, and transmit data securely, smart meters are paving the way for a more sustainable energy future.

The adoption of smart e-meters is rapidly increasing worldwide due to growing energy demands and the need for more efficient energy systems. According to the U.S. Energy Information Administration, in 2022, U.S. electric utilities had about 119 million advanced (smart) metering infrastructure installations, equal to about 72% of total electric meter installations. As the adoption of smart meters accelerates, key trends are emerging that shape the evolution of this technology.

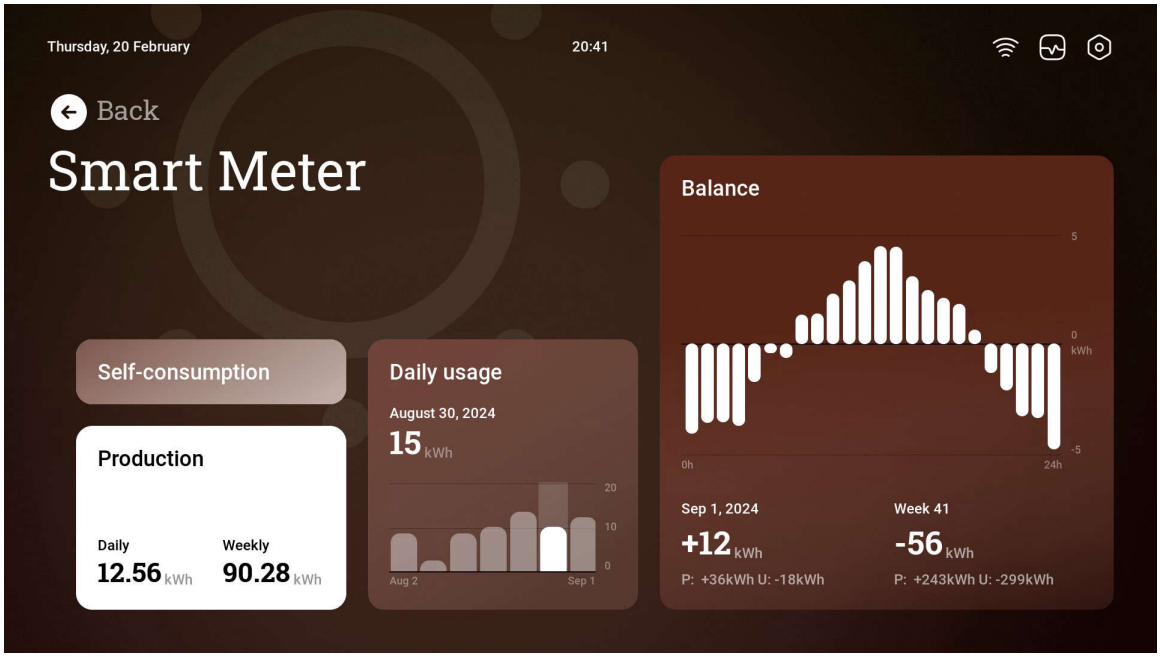

Figure 1. Energy Monitor on AM62L

One of the key trends in smart e-metering is an increased need for higher performance. While most smart meters today can utilize either a microcontroller unit (MCU) or a microprocessor unit (MPU), the growing complexity of modern designs has led to a greater reliance on MPUs. MPUs are essential for handling real-time data processing, security and connectivity requirements. To support these functions, embedded processors must integrate communication stacks such as Wi-Fi®, Bluetooth®, Zigbee®, and cellular 5G, which enables reliable data transmission between meters, utilities and other grid components.

Additionally, security is a must have requirement in smart e-meters. As e-meters are critical for our grid infrastructure, it is essential for utilities companies and households to have secure e- meters. Security enabled MPUs prevent tampering, cloning, and hacking of e-meters. In MPUs, operating systems such as Linux® offer essential features such as secure boot, cryptographic encryption, and protection against hacking and tampering. While basic smart meters can operate with an MCU running a real-time operating system (RTOS), more advanced implementations require greater flexibility and processing capabilities to support multi-protocol communication and over-the-air updates. The AM62L processor helps bridge the gap between MCU and MPU-based designs by offering a balance of performance, security, and connectivity.

In addition to trends in performance and security, several other key trends are shaping the evolution of smart e-meters. These are not only driven by advancements in hardware and software but also by regulatory requirements, security needs, and the push for sustainability. Understanding these trends provides insight into how smart e-metering continues to evolve and impact the broader energy landscape. Some of them include:

Software Advancements

Modern smart e-meters rely on operating systems such as Linux and RTOS to manage data analytics, user interfaces, and communication protocols. Linux can enable more advanced features such as security, real-time alerts, detailed energy consumption reports, and integration with smart home systems. Companies are enhancing smart e-meter software to provide customers with greater control over their energy usage, improve grid forecasting, and enhance the user experience. Additionally, more advanced smart e-meters act as a gateway hub or include a display where lightweight graphics are necessary.

AI and Data Analytics

Artificial intelligence (AI) and data analytics are transforming smart e-meters by enabling real-time monitoring, predicting maintenance needs, and identifying irregular consumption patterns. Additionally, smart e-meters are using AI models to analyze historical power consumption and showcase load and energy consumption forecasts.

To enable this on the edge, higher end smart e-meters require additional performance. With up to two Arm® Cortex®-A53 cores, the AM62L processor provides robust computing to enable edge AI models, real-time data processing and analytics directly on the device that cannot typically be done on MCUs. The edge AI capabilities on the AM62L SoC reduces reliance on the cloud, lowers latency, enhances security and allows for more efficient data-driven decision making.

Compact Form Factors and Low-Power Consumption

The development of smaller and more compact smart e-meters requires MPUs with a small form factor. Additionally, these compact MPUs must have low-power consumption to enable smaller fan-less designs. The AM62L processor enhances energy efficiency with its low power modes that improve thermal management, reduce heat dissipation, and provide long term reliability. The device is a small 11.9 x11.9 mm processor with active-power consumption less than 1 Watt. Processors such as the AM62L make it easier to integrate into existing infrastructure, reducing total cost with a low cost TPS65214 PMIC.

IoT Integration

The rise of Internet of Things (IoT) devices has accelerated smart e-meter deployment, enabling seamless connectivity and data exchange. IoT integration allows smart e-meters to communicate with other devices, including home automation systems, utility grids, and renewable energy sources. This connectivity enables advanced functionalities like remote monitoring, predictive maintenance, and automated energy optimization. Companies are adopting IoT-enabled smart meters to enhance operational efficiency, reduce maintenance costs, and provide real-time insights into power usage trends. Additionally, the integration of Wi-Fi®, *Bluetooth*®, and Zigbee™ ensures enhanced compatibility with modern smart home ecosystems.

Conclusion

As smart metering technology evolves, the AM62x family of processors from TI can enhance security, efficiency and connectivity in e-meters. With increasing energy demands and the push for sustainability, the integration of AI, IoT, and renewable energy management continues to shape the future of smart e-metering.

As the global energy landscape continues to shift towards sustainability and digitalization, the AM6x processors play an important role in advancing smart e-meter technology and building a more efficient and resilient energy future.

Additional Information and Resources

- AM62L Product Page
- AM62L Product Overview
- AM62L Device Academy
- AM62x Product Page
- AM62x Design Gallery
- AM62x Device Academy
- TPS65214 PMIC Product Page

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