If you don't plan to scale, you plan to fail

How designing with MSP430™ FRAM-based microcontrollers help future-proof your product

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Microcontrollers are at the heart of over a billion intelligent devices in the world today. We interact with, learn from and rely on these devices every day for a wide variety of tasks. If you are working on developing a microcontroller-based product, you most likely want to ensure your system is future-proof. This helps minimize incremental redesign efforts and shifts focus towards innovation. In order to achieve success in this effort, it is important to understand emerging trends in embedded electronics, and select the correct products for your design today. The MSP430™ FRAM-based microcontrollers from TI are designed to solve the largest scalability challenges that embedded developers face.

A look at popular products at tradeshows over the last two years gives us indicators on where the electronics industry is headed. Products on the cutting edge of solving problems are doing so by requiring less human interaction, more reliability, increased security and connecting directly to the now ubiquitous smart phone. These improvements are all occurring along with products that feature smaller form factors and consume less power. While this seems to be a tall order, some simple checks when starting a system design can help shift development closer towards the goal of building a future-proof product.

Do more for less (energy)

Engineering is a closed loop process that requires collecting feedback, making changes and adapting to a changed environment. The consumer market serves as a good example for this process. When a product is revised the expectation is always to add functionality while supporting lower energy profiles and reduced form factor (battery size). As an example, consider a first generation e-reader that supported up to 7 days of charge on a 1530mAH battery. The second generation increased performance specifications (for example, 20 percent faster screen refresh) while simultaneously promising twice as many days of charge (up to 14 days) with the same 1530mAH battery. Hence, it is important to select a microcontroller from a portfolio that can offer both ultra-low power and memory scalable options. The MSP430FRx MCU family provides pin-compatible options across different memory ranges with extremely low active, standby and peripheral power. The microcontrollers are also built with peripherals that can perform functions without CPU intervention – the MSP430FR41xx devices can drive LCDs in the lowest power mode (deep sleep) consuming under 800nA of current.

In many cases, iterative generations add connectivity to the product while maintaining the current energy profile. For example, smart locks based on the MSP430 may require the addition of NFC to scan for

An NFC-based smart lock that can be controlled from a smart phone

authorized users. This can be easily achieved by selecting a higher memory, pin-compatible product within the same ultra-low power portfolio. Also, the FRAM devices operate at the industry's lowest active power of 100uA/MHz allowing the application to increase the CPU active duty cycle without significant penalty to the overall energy budget. Operating on a lower energy budget means that products can use less conventional, energy harvested power sources saving cost and maintenance effort on the power supplies.

In addition to the above mentioned benefits, the MSP430FR5x and FR6x devices support Energy Trace++, an advanced energy debugging ecosystem. Energy Trace++ allows users to view energy consumption in real time by seeing the breakdown of active, standby and peripheral power. The closed-loop process of analyzing, debugging and correcting energy issues with Energy Trace++ allows developers to complete their design quickly and efficiently.

Add a 'smart' component

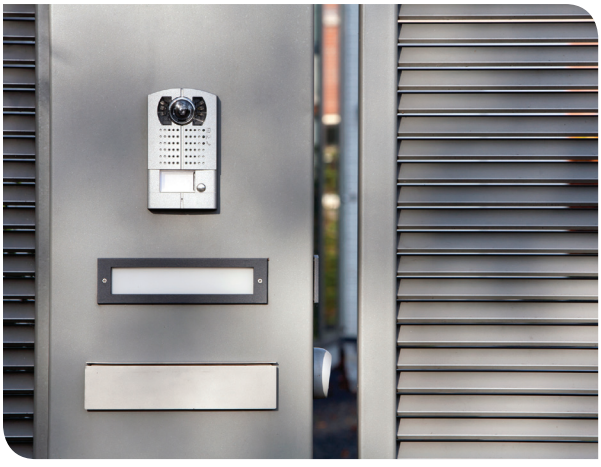
Embedded systems today are becoming increasingly focused on providing context-aware solutions that can gather and store data from the surrounding environment, process it and make intelligent decisions without the intervention of or the need to transfer data to a more powerful host. A critical aspect of this function involves sampling and storing sensor data over large periods of time. A good example of this can be observed on factory floors where diagnostic modules are used to detect the wear on machinery such as motors. These diagnostic modules record machine signatures (thermal, vibration, etc.) and later apply pattern recognition algorithms to schedule routine maintenance checks and prevent system malfunction. Embedded FRAM-based microcontrollers are well suited for such applications, because these MCUs can write to non-volatile memory faster and with lower energy.

Motors with diagnostic modules on a factory floor

Other important aspects to consider are the component redundancy and frequent data readouts that such modules need to ensure reliability. FRAM-based systems have extremely high endurance (10^15 write cycles) allowing longer intervals between checks and reduced frequency of readouts. FRAM writes are also non-blocking and do not require pre-erase, allowing the CPU to respond faster and work with more efficiency. This means that the diagnostic module does not miss any events and can log them in real time even during data writes. Also, modules are replaced and read out at lesser frequency, providing a more efficient and lower cost factory maintenance system.

Connect to the Internet of Things

Many industry experts are now referring to the emergence of the Internet of Things (IoT) as a turning point in embedded technology. Wireless sensor nodes illustrate the impact of the vast proliferation of IoT into everyday functions. Consider an ambient light detector that can regulate and control blinds in large buildings automatically. The sensor node (light detector) is always on and periodically uses the radio to communicate to the blinds controller depending on the sensor information. Now these sensor nodes also need to be able to connect to the Internet and enable an end user to remotely monitor, track and make data-based decisions (such as shutting the blinds of an office complex for the weekend using a remote smart phone or tablet).



Electronic window blinds can be controlled remotely using a phone or tablet

However, in many cases, such wireless sensor nodes are retrofitted in buildings and are battery powered. Stand-alone radios (Wi-Fi®, Bluetooth®, etc.) can be aggressive power consumers and can cause significant battery drain in a short time depending on the implementation and silicon solution being used. Therefore, it is important to isolate the sensing and radio communication functions using an ultra low-power system supervisor that can manage the sensor function and communicate to the radio as needed. Using an FRAM-based MSP430 microcontroller allows the system to detect and log sensor data continuously and make autonomous decisions while only waking up a power hungry radio as needed for communication. The low active power and the ultra low-power FRAM writes ensure that these battery operated systems can function efficiently with a very low energy profile.

Secure communication

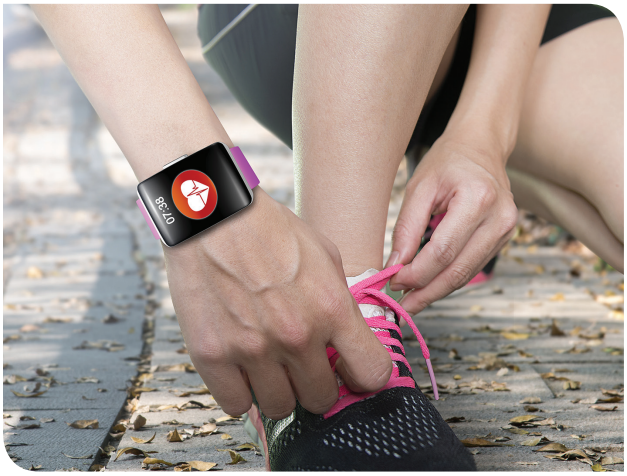
Given how connected our world is today, addressing security concerns is becoming a universal need. However this involves securing a diverse and evolving range of “links” starting from large data servers down to the smallest connected node. Recent attacks on payment transactions have made the news and prove that a system is only as secure as each of its nodes. What are these nodes? How do we start approaching the task of ensuring the required level of security and what measures can we take to arm ourselves against threats? Answering these questions is the first step towards closing

security gaps and ensuring your system is protected from threats that can weaken it or make it non-functional. “Extract from security white paper”

To illustrate the importance of thinking ahead when it comes to security, consider a company designing boards that serve as metrology processors for utility and residential electricity meters. The microcontroller selection needs to be based not just on current but also future needs like industry standards or regulations that will be adopted five years from now. Some metering systems today isolate the metrology and communication functions. A future government regulation may require that all channels of communication between these functions need to be encrypted to prevent data hacks or other external threats. In such a case it makes sense to design a system with built-in encryption accelerators that can be enabled on an as-needed basis. The MSP430FR5x and MSP430FR6x microcontrollers provide a 256-bit AES accelerator that is low power and can operate autonomously to encrypt and decrypt data. These devices also provide a 128-bit true random seed that can be used to implement a deterministic random number generator for key creation. Another advantage of the AES accelerators is that it allows users to encrypt firmware updates or device readouts from a remote location. This, combined with the ability to perform over-the-air updates on ultra-low power FRAM, ensures that firmware upgrades are securely and reliably completed.

Reduce system size

Almost every industry from consumer accessories to wearable technology is facing the challenge of reducing the overall form factor of their product in iterative designs. There is an insatiable demand in the electronics industry for miniaturization, and this in turn, impacts the embedded industry to not only make smaller devices but to also integrate more in each device. MSP430 FRAM-based MCUs address both vectors. The MSP430FRx microcontrollers provide a variety of integrated analog such as a 12-bit differential analog-to-digital convertor (ADC), comparators, security accelerators, etc. In addition, if the system is currently using external memory for data storage, this function can be easily and efficiently integrated into FRAM-based microcontrollers. MSP430 FRAM MCUs also feature multiple package options including a 2mm x 2mm die size BGA package (also referred to as a wafer-level chip-scale package ““WLCSP”) on the MSP430FR573x family. Having a diverse portfolio to choose from ensures that designers can always pick the most optimized form factor for their product now and in the future.



Wearable fitness tracker in a small form factor

Understanding evolving trends and designing embedded systems to assure they are compatible with future system requirements begins with selecting the best microcontroller family. A scalable product is built by not only anticipating future needs

but also by building a system that can take on additional functions while continuing to operate in a reliable and efficient manner. Texas Instrument's MSP430 FRAM Microcontrollers are highly integrated, easy to use and provide a wide variety of ultra-low-power options to choose from ensuring that your product will have scalability built right into the design.

For more information

Explore the portfolio of over 100 FRAM Microcontrollers.

Check out the ultra-low-power MSP430FR6972 MCU, our newest addition to MSP430FRx series, sampling now.

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