If you don’t plan to scale, you plan to fail
How designing with MSP430™ FRAM-based microcontrollers help future-proof your product

Priya Thanigai
Product Marketing Engineer
MSP430 microcontrollers
Texas Instruments
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...
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 \((10^{15} \text{ write cycles})\) 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).

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 converter (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](image-url)

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.
IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to additional restrictions.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Buyer acknowledges and agrees that any military or aerospace use of TI components which have not been so designated is solely at the Buyer’s risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio
www.ti.com/audio

Amplifiers
amplifier.ti.com

Data Converters
dataconverter.ti.com

DLP® Products
www.dlp.com

DSP
dsp.ti.com

Clocks and Timers
www.ti.com/clocks

Interface
interface.ti.com

Logic
logic.ti.com

Power Mgmt
power.ti.com

Microcontrollers
microcontroller.ti.com

RFID
www.ti-rfid.com

OMAP Applications Processors
www.ti.com/omap

Wireless Connectivity
www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation
www.ti.com/automotive

Communications and Telecom
www.ti.com/communications

Computers and Peripherals
www.ti.com/computers

Consumer Electronics
www.ti.com/consumer-apps

Energy and Lighting
www.ti.com/energy

Industrial
www.ti.com/industrial

Medical
www.ti.com/medical

Security
www.ti.com/security

Space, Avionics and Defense
www.ti.com/space-avionics-defense

Video and Imaging
www.ti.com/video

TI E2E Community
e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2015, Texas Instruments Incorporated