This presentation provides an overview of the MSP430 family of ultra-low power microcontrollers, its features and applications.
What Is The MSP430?

Ultra-low Power
- 0.1µA power down
- 0.8µA standby mode
- 250µA / 1MIPS
- <1µs clock start-up
- <50nA port leakage
- Zero-power BOR

Ultra-Useful
- 1k-128kB ISP Flash
- 14-100 pin options
- USART, I2C, Timers
- 10/12/16-bit ADC
- DAC, OP Amp, LCD driver
- Embedded emulation

MSP430 - Mixed Signal Processor. The features of the MSP430 family make the product ideal for battery-powered measurement applications.

Ultra-low Power; The MSP430 architecture is designed specifically for ultra-low power applications – specific operating modes are implemented to reduce power consumption and dramatically extend battery life. The real-time clock mode uses as little as 0.8µA which is actually lower than the self-leakage of most batteries. Many MSP430 customers have developed battery-based products that will last for over 10-years from the original battery!

In addition to the MSP430’s for its ultra-low power, thousands of engineers are also using the MSP430 for its modern 16-bit RISC architecture and advanced peripherals to solve a variety of design challenges. Because the MSP430 uses a modern 16-bit RISC CPU, engineers can embed advanced signal processing features into their products that were not possible conventional 8-bit MCUs. A flexible Von Neuman architecture, analog peripherals including ADC’s, comparators, DAC’s, LCD drivers and supply voltage supervisors are integrated to support precision measurement. These peripherals enable better products to be built using fewer chips and implement a true signal chain on chip (SCoC).

Applications operating at lower voltages, with smaller packaging and higher-precision analog benefit greatly from the MSP430’s embedded emulation approach. Dedicated emulation logic resides on the device itself and is accessed via industry standard JTAG using no additional system resources. From the first day of development, engineers can now unobtrusively develop and debug their system; full-speed, with breakpoints, with single steps and even trace signal in an application.

Embedded emulation becomes even more important with mixed-signal systems that must maintain the integrity of small analog signals - this impossible with cumbersome in-circuit emulators that are sensitive to cabling crosstalk. And unlike abstract background debuggers, no time-sharing of system serial communication resources is required with embedded emulation on the MSP430. By combining the flexibility of in-system programmable Flash memory, unobtrusive embedded emulation, and a common user interface, development time is reduced. And, should the situation arise, last minute code updates as well as remote scheduled and unscheduled upgrades can also be made.
The overall embedded processor market TAM including DSP is approximate $20B, this is represented by the green bubble.

AEC addresses the MCU portion of the TAM with three distinct product families optimized for each segment;

The C2000 family addresses the high end of the 32-bit MCU and low-end of the DSP market. The primary applications areas targeted are motor control and digital power supply. Up to 150 32-bit high-quality DSP MIPS are offered.

The TMS470 is based on and industry standard ARM7TDMI and was originally developed to target to 32/16-bit automotive applications. A focused subset of the product line is available now to the general purpose market for a wide range of industrial applications that include medical instrumentation, point of sale terminals and communication gateways.

The MSP430 family targets 8-bit and low-end 16-bit ultra-low power measurement applications. The product line offers end-equipment specific metering, instrumentation and sensing solutions and is also used throughout a wide range of catalog applications. The product is noted specifically for lower power with devices starting as low as $0.49.
The MSP430x3xx family was the first MSP430 family introduced in the late ’90’s. ‘3xx devices have an integrated LCD driver and are primarily used by customers in high-volume metering applications. The ‘3xx family operates from 2.5V – 5.5V offering ROM and OTP - no new ‘3xx devices are planned.

The MSP430x1xx family was introduced in 2000 to address requirements across a wide range of catalog applications. The ‘1xx family introduced the MSP430’s ultra-low power Flash and is specified for operation at up to 8-MIPS and at voltages as low as 1.8V. The ‘1xx family spans a wide variety of devices from the entry level MSP430C1101 ROM device starting at $0.49, to highly integrated ’16xx devices with up to 60kB of Flash, 12-bit ADC, 12-bit DAC, DMA controller, and up to 10K RAM. All MSP430x1xx family members are in high-volume production and encouraged for new designs.

The MSP430F4xx complements the ‘1xx family adding an LCD driver, zero power BOR and an enhanced Frequency Locked Loop (FLL) clock system. The’ 4xx offers Flash memory, 8-MIPS and low voltage operation just as in ’1xx. The ‘4xx family is targeted to metering and measurement end-equipments and as such is considered Application Specific Standard Product. The ‘4xx offers a high-resolution 16-bit sigma-delta A-D converter, operational amplifiers, and other embedded analog functions ideal for single chip solutions. Many additional ‘4xx derivatives are planned with new peripherals. It is planned in the 4xx family to increase the memory range to 128KB. The ‘4xx family is encouraged for new designs.

The MSP430F2xx family provides twice the processing performance at half the stand-by consumption compared to MSP430F1xx devices. In addition, the MSP430F2xx family incorporates enhancements that reduce overall system cost and improve reliability making these new devices an ideal solution for existing low power MSP430 designs or as a launch point for a variety of new applications. ‘2xx Family is planned for introducing throughout 2005 and 2006; The ‘2xx is introduced as an upgrade path for existing ’1xx users or as a great starting point for new applications. The ‘2xx family will be pin and functionally compatible with ‘1xx devices offering even lower power, more speed, BOR, WDT+ on every device along with a variety of new peripherals.

The MSP430x5xx is planned for introduction LATE 2006; The family will offer expanded memory, more speed and a variety of new peripherals. Additional ‘5xx information will be available fall 2005!
The MSP430 is designed specifically for battery-powered measurement applications.
The average system power consumption is the absolute lowest, without compromise in performance.
The system enters and remains as long as possible in an ultra-low power standby mode and is awoken only to service interrupts and then as fast as possible.

Multiple oscillators are utilized to provide both an ultra-low power standby mode, and “on-demand” high-performance processing. The clock system is very flexible and allows the MSP430 to operate optimally from a single 32KHz crystal – with the internal digitally controlled oscillator (DCO) used for the CPU and high-speed peripherals.

A low frequency Auxiliary Clock (ACLK) is driven directly from a common 32KHz watch crystal with no additional external components. The ACLK enables the MSP430’s ultra-low-power standby mode (LPM3) and an embedded real-time clock function. In LPM3, the MSP430 typically consumes in the 1uA range.

The integrated high-speed DCO can source the master clock (MCLK) used by the CPU and high-speed peripherals. By design, the DCO is active and fully stable in less than 6 µs no intermediate steps. This enables “instant on” high-performance processing – no long start-up for a second crystal or 2-speed start-up required. Because the DCO is digitally adjustable with software and hardware, stability over time and temperature are assured.

To service interrupt driven events, the software efficiently uses the 16-bit RISC CPU’s performance in very short, “burst” intervals. Transition from standby to full active is less than 6us. This results in a combination of ultra-low power consumption and very high-performance immediately when needed.

To support non-low power applications, a high-speed crystal up to 16Mhz can also be used. The device can also operate with no external crystal using only the internal DCO.
So why is ultra-low power so important?
The most apparent benefit for low-power is realized in battery powered applications. Reduced power consumption allows the use of smaller lower cost batteries. Generated EMI is very low because the MSP430 is so low power and can operate effectively at low-frequencies.
Even in application that have a power supply, low-power is an advantage. Smaller, lower cost power supplies can be used.
Another benefit in battery powered application is the concept of permanently installed batteries. The idea is to install sealed batteries at the factory that are not replaceable. With permanently sealed batteries in an application such as a portable medical device, replacement liability is eliminated. Cost is also reduced. With MSP430’s ability to operate <1uA, it is very possible to develop product the operate from a single lithium battery for over 10-years.
Performance on Demand

- Immediate-stable clock start for reaction to events

The screen capture shows the actual startup of an MSP430 DCO!
In this example it can be seen that from an interrupt event the DCO is active and stable in well under 6μs. In fact, in this example the measured MSP430F2131 DCO startup time is actually 204ns.
With the MSP430, clock start up is “instant-on”. It is important that the high-speed DCO not only starts instantly, but also stabilizes instantly. Both instant-on and instant stability are important to support asynchronous serial communication for example.
With the MSP430 DCO, no delay or 2-speed clock startup occurs. The users application has instant access to the high-speed DCO from any operating mode.
A common benefit of an instant-on and stable oscillator is response to serial communication, a 19200 baud UART for example. As long as the oscillator – as the clock source for the UART - starts instantly and is stable, no characters are lost. If a slow or 2-speed oscillator is used, the first character in the received data stream is lost.
Instant-on saves power as the system does not have to waste energy waiting for start up. Activities are serviced immediately.
Modern 16-bit RISC CPU is optimized for modern programming techniques.

The MSP430’s architecture provides the flexibility of 16 fully addressable, single-cycle 16-bit CPU registers. The large CPU register file eliminates what is typically a single working file or accumulator bottleneck. The CPU registers are fully accessible including the program counter, stack pointer, status register and 12 working registers.

The CPU also integrates a constant generator to automatically generate the six most used immediate values. The constant generator has the effect of reducing code size by generator this common constants (or literals) using hardware, eliminating what would be immediate values embedded in code.

The modern Reduced Instruction Set (RISC) design of the CPU offers versatility through simplicity using only 27 easy-to-understand instructions and seven consistent addressing modes. All memory spaces – Flash, RAM, peripherals and CPU registers - use the exact same instructions and addressing modes. All instructions can also be used in a byte format as well. The MSP430 is an orthogonal design because all instructions are used consistently though all areas of the device.

Up to 16 MIPS of performance is available today on the newest 2xx family, with more planned.

The result is a 16-bit, ultra-low power CPU that has more effective processing throughput, is smaller in size, and more code-efficient than other 8/16-bit microcontrollers. When using the MSP430, this results in programmers writing less lines of code. Now it’s possible to develop ultra-low power, high-performance applications at a fraction of the code size previously possible.
The MSP430 uses a single unified memory address map for code, data and peripherals. There is absolutely no paging with direct access to program and data anywhere throughout the entire address space which include Flash, ROM RAM and peripherals with no restrictions. Support for agile unrestricted code including branching, subroutine calls, function calls and interrupts are supported. All of the Flash and RAM memory can be addressed as either 8-bit bytes or 16-bit words.

Peripheral module address are collected below 0x200. The complete instruction set and all addressing modes can be used with peripherals.

Flash is segmented into 512B main memory segments. Additional smaller information memory segments are also available. The only difference between main and information memory is size – code and data can be located anywhere. The total number of main memory segments depends on the device - for example, a 4KB device has eight main memory segments.

Flash memory operates from 1.8V – 3.6V. Programming/erase voltage is 2.7V (reduced to 2.2V on the ‘F2xx). Flash can be erased and reprogrammed 100k times with 100 year data retention typical. 60kB of Flash can be programmed in as fast as 2 seconds.

There are three methods of programming Flash; Out or in-system using JTAG, a Bootstrap Loader (BSL) or in system using normal software. The bootstrap loader is a section of ROM code that resides on the device itself and allows communication using a common 9600 baud UART protocol. Information regarding the BSL is also available on the MSP430 website.

The sequence to program Flash is very easy with timing controlled by hardware. For security reasons, Flash can not be programmed or erased unless a password is used when the Flash control registers are accessed. During programming and erase program execution is automatically halted. After the operation software resumes with the next instruction and any enabled interrupts that occurred during the programming or erase operation are automatically serviced.
The example shows how powerful a modern instruction set is in a real-world application. An code effective architecture like the MSP430 not only reduces code size and execution time but also reduces the lines of code required for a given function.

Using indirect addressing with the MSP430, in a single line of code, a display character can be written directly to a port to illuminate a seven segment LED display for example.

In the example the variable DispVal holds the value to be displayed. A look-up table decodes the character map directly which is written directly to the port in a single instruction. Because the MSP430 is a Von Neuman architecture, the data table can be located anywhere in the memory map.

Comparing the MSP430 to an other common 8-bit MCU, the power of a modern instruction set is seen. The MSP430 requires only 128 bits of total program and lookup table memory for the function in the example. The other MCU requires 238 bits for the same function.
The example shows the effectiveness of the MSP430’s 16-bit architecture in a common function, the process of servicing an integrated 10-bit ADC saving the conversion code to RAM.

The MSP430 can move any 8 or 16-bit value from any memory location to any memory location in the entire address space in one fully atomic (uninterrupted) instruction.

The 8-bit MCU requires numerous instructions, and is forced to break the 10-bit ADC output into two bytes. The limitation of an accumulator based architecture is also shown with data always passing through the accumulator. The need to always pass data through the accumulator and being forced to change memory pages with the 8-bit MCU increases code size, reduces performance and increases power consumption.
Many applications today are developed in high-level C code. To achieve the highest C code efficiency, first consider what a compiler wants. Compilers prefer instruction set orthogonality and many registers that operate identically to be free to allocate resources without restrictions. Compilers also use the stack for passing parameters and for storing temporary variables.

With these facts and guidelines, the MSP430 architecture was developed as follows:

- **Complete orthogonal instruction set** – Although the MSP430 architecture implements only 27 instructions, every instruction is usable with every addressing mode throughout the entire memory map. This enables a very compact instruction set to implement a very large feature set with a strongly simplified, lower cost and lower power CPU.

- **High register count** - In addition to the program counter and stack pointer, twelve identical general purpose 16-bit CPU registers are available.

- **Page free** - The 16-bit architecture of the MSP430 allows the direct addressing of the entire 64kB memory address space.

- **Stack processing** - The stack pointer has the full addressing capabilities of a general purpose register which allows any needed manipulation of data on the RAM-based stack. Usability of jumps - eight single word conditional jumps with a large ±512 reach are implemented.

- **Three addressing modes** (symbolic, absolute and immediate) allow fully atomic memory-to-memory operations with the complete instruction set. These addressing modes drive significant code savings and superior performance.

- **Byte and word processing** - Any instruction can be used with 16-bit word or 8-bit byte data type. This feature is especially useful for table processing allowing the use of the most code efficient data type.

- **Constant generator** - The constant generator automatically generates the six most used immediate constants in hardware.

**Compiler Friendly**

- **Instruction set and register orthogonality**
- **Direct stack addressing for passing parameters**
- **Application report SLAA205**
The MSP430x1xx family was introduced in 2000 to address requirements across a wide range of catalog applications. The ‘1xx family introduced the MSP430’s ultra-low power Flash and is specified for operation at up to 8-MIPS and at voltages as low as 1.8V. The ‘1xx family spans a wide variety of devices from the entry level MSP430C1101 ROM device starting at $0.49, to highly integrated ’16xx devices with up to 60kB of Flash, 12-bit ADC, 12-bit DAC, DMA controller, and up to 10K RAM. All MSP430x1xx family members are in high-volume production and encouraged for new designs.

<table>
<thead>
<tr>
<th>Device</th>
<th>Pins</th>
<th>Max Flash</th>
<th>Max RAM</th>
<th>BOR</th>
<th>Features</th>
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<tbody>
<tr>
<td>MSP430x11x1</td>
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<td>4KB</td>
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<td>As low as $0.49</td>
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<td>MSP430F11x2</td>
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<td>USART</td>
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<td>MSP430F12x2</td>
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<td>8KB</td>
<td>256B</td>
<td>√</td>
<td>ADC10/USART</td>
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<td>MSP430F13x</td>
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<td>16KB</td>
<td>512B</td>
<td></td>
<td>ADC12/USART</td>
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<tr>
<td>MSP430F14x</td>
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<td>60KB</td>
<td>2KB</td>
<td></td>
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<tr>
<td>MSP430F15x</td>
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<td>32KB</td>
<td>1KB</td>
<td>√</td>
<td>F13x+(2)DAC12/DMA/I2C</td>
</tr>
<tr>
<td>MSP430F16x</td>
<td>64</td>
<td>60KB</td>
<td>10KB</td>
<td>√</td>
<td>F14x+ (2)DAC12/DMA/I2C</td>
</tr>
</tbody>
</table>
Pictured actual size is the MSP430F1121 in a 4mm x 4mm QFN package. Many battery powered applications are portable, and chip size is very important. MSP430 are offered in a variety of pin-counts and packaging including the space-saving QFN package.
The MSP430F1xx2 devices are ideal for portable, battery-powered applications that require real-time digital signal processing such as the glass break detector shown.

This battery-powered application operates the ‘F1132 normally in LPM3 (~ 1.5uA). In intervals of 10ms, the timer_A output register TA1 automatically brings the OPA out of shutdown mode and triggers the ADC10 to take a quick burst of samples. Only after the ADC10 sample burst is complete and all the acquired data has been transferred to RAM by the DTC will the CPU be interrupted. The interrupt forces the CPU active and the high-speed DCO on.

The CPU processes the short sample of acquired data to determine if an appropriate energy signature is present. Only if a possible glass break is calculated will the CPU immediately restart the ADC10 and continue acquiring samples for detailed analysis.

The DTC automates ADC10 data handling allowing the CPU to remain in a low-power to save power or to focus on signal processing and not simple data handling. The DTC improves performance, reduces power consumption and reduces code size allowing sophisticated applications to be developed.

Because the solution is MCU based the system can be adaptive using software intelligence to adapt to a changing environment. For example, if the average noise level has increased, the MCU can raise the threshold for a possible glass-break – eliminating false triggers. Not all of the ‘F1132’s resources are used, it is possible to implement other features such as serial communication – including UART or Manchester encoded wireless.
The MSP430F15x/16x families are 100% pin compatible and are functional extensions of the popular ‘F14x/13x families.

Additional analog features are available that enable higher reliability, integration and performance.

A programmable supply voltage supervisor is added for very accurate supply voltage monitoring. If the supply falls below a programmed level, the device can be configured to completely reset, preventing errant operation.

Two 12-bit DAC’s generate independent analog outputs.

The USART0 is enhanced to support full master/slave I2C operation in addition to the UART and SPI modes.

A direct memory access controller (DMA) controller allows programmable and automatic data handling from any memory location to any memory location.
The benefits of using DMA for repetitive data handling are very significant in real world applications. The example shows an instrument that must generate a 32 step 10kHz sine wave into a sensor. This means that 320k DAC transfers are required. Without DMA the typical interrupt driven software solution quickly becomes overloaded just managing the serial transfers to the DAC.

The DAC load ISR requires CPU 53 cycles to fetch the required data from a look-up table, increment an pointed, increment a pointer, check pointed for out of range and load the fetched data – which is equivalent to > 16MIPS.

With DMA the total system clock requirements are 0.64MIPS – DMA reduces system overhead in this example by over 25X.

With DMA and signal-chain-on-chip the performance of a system is dramatically increased and the MCU resources are available for more advanced signal processing. This means that MSP430 applications can operate at lower clock speeds - reducing power consumption and EMI – and deliver higher performance.
# MSP430x4xx ASSP Devices

<table>
<thead>
<tr>
<th>Device</th>
<th>Pins</th>
<th>Max Flash</th>
<th>Max RAM</th>
<th>LCD</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
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<td>96</td>
<td>&lt; $2</td>
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<td>32KB</td>
<td>1KB</td>
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<td>32KB</td>
<td>512B</td>
<td>56</td>
<td>SD16/DAC12</td>
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<td>32KB</td>
<td>1KB</td>
<td>128</td>
<td>SD16/USART</td>
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<tr>
<td>MSP430FE42x</td>
<td>64</td>
<td>32KB</td>
<td>1KB</td>
<td>128</td>
<td>ESP430 E-meter/USART</td>
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<tr>
<td>MSP430F43x</td>
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<td>32KB</td>
<td>1KB</td>
<td>128</td>
<td>ADC12/USART</td>
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<tr>
<td>MSP430FG43x</td>
<td>80</td>
<td>60KB</td>
<td>2KB</td>
<td>128</td>
<td>F43x+(2)DAC12/DMA/OA</td>
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<td>MSP430F44x</td>
<td>100</td>
<td>60KB</td>
<td>2KB</td>
<td>160</td>
<td>F43x+(2)USART/MPY</td>
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<tr>
<td>*MSP430F46x</td>
<td>100</td>
<td>120KB</td>
<td>2KB</td>
<td>160</td>
<td>FG43x+USCI</td>
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</tbody>
</table>

*Planned future devices

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A common application for MSP430 is a battery powered thermostat with display. The MSP430F413 system operates normally in standby mode LPM3 at ~0.8uA. When operating in LPM3, the watch-crystal oscillator (ACLK), a timer, the LCD driver and all interrupts are active. Once every second, the timer clocked by ACLK overflows and interrupts the CPU, which automatically starts the DCO. The CPU updates software based clock registers. Please keep in mind that when active, the CPU is operating from the fast DCO – not the slower ACLK. The update of the clock registers takes less than 100us. 

Because the active duty cycle for the embedded real-time clock function is so low taking only about 100us every 1 second - 100/1000000 - the incremental current consumption is only 30nA.

Every few seconds the MSP430F413 measures the resistance of a thermistor using an integrated precision slope ADC. The temperature is calculated and displayed. Because the ADC function occurs only every few seconds, the current impact is very low.

Many other MSP430F413 resources are fully available for additional system features. 

The current consumption for the entire system including the MSP430, LCD and RTC and ADC function is only 2uA. Because of the entire system’s ultra-low power consumption, the application can operate for 10-years from a common coin cell battery.
The MSP430FE42x family introduced the industry’s first single chip electricity meter. All components for a single phase e-meter are integrated in the ‘FE42x family, including an embedded signal processor (ESP) metrology function. By combining an industry-standard ultra-low-power Flash MCU with an integrated high-performance analog front-end embedded signal processor (ESP) on a single-chip, the new MSP430FE42x family of products reduces the total system chip count by eighty percent, improving performance and reliability, while reducing cost and time to market when compared to first generation electronic solutions. Having critical energy calculations managed completely by ESP430CE1 frees the MCU functions for users to implement differentiated meter features such as display and automated meter reading (AMR). The ESP430 integrated in the MSP430FE42x provides compete functionality for a hassle free single-phase e-meter solution.

To provide the highest possible performance and simplify system design, the ESP430CE1 is a complete encapsulated single phase e-meter module. Three independent 16-bit sigma-delta ADCs, programmable gain amplifiers, a temperature sensor and a precision voltage reference under the control of a dedicated DSP430 are all integrated to perform the energy metrology function.

The converted line voltage and current signals are digitally processed, providing energy and line period measurement; negative power flow indication; peak voltage and current; and phase and line-to-neutral current comparisons for tamper detection.

With precise phase matching between current and voltage channels, the ESP performs the necessary calculations to supply accurate active energy, apparent energy, RMS voltage, current and waveform samples. The ESP provides a 0.1% accurate energy measurement over a dynamic current range of 1000 to 1, greatly surpassing the 1 percent accuracy common in typical mechanical meters.
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‘2xx Family is planned for introducing throughout 2005 and 2006; The ‘2xx is introduced as an upgrade path for existing ‘1xx users or as a great starting point for new applications. The ‘2xx family will be pin and functionally compatible with ‘1xx devices offering even lower power, more speed, BOR, WDT+ on every device along with a variety of new peripherals. New peripherals including a USCI (USART/SPI/I2C/IrDA), 128kB (120kB Flash) memory and low pin variants are planed.
The example shows how easy it is to program and use the MSP430 in a very basic ‘Flash the LED’ application!

Only a few things need to be configured for basic operation; The stack pointer, watchdog and reset vector.

The MSP430 has an addressable software stack that must be initialized – usually to the top of available RAM. Because the MSP430 uses a software stack, there is virtually unlimited nested interrupt and software subroutine call capability. Because the stack is fully addressable, C-compilers, which extensively use stacks, are very efficient.

The watchdog powers up active for security reasons. User software must turn-off or reconfigure the watchdog within 32ms or else a reset will occur.

The RESET vector holds the address of where software begins. This is the address placed on the program counter (PC) at reset.

The LOOP simply toggles port pin P1.0, using an “xor” instruction, in an endless loop.

Because the MSP430 can run directly from the internal DCO, no crystal is needed for this very basic application!
Embedded Emulation with the MSP430. A common user software and physical interface is used for all MSP430s. This means only one tool needs to be learned for any device.

The Flash Emulation Tool – or FET – is a complete JTAG based real-time Integrated Development Environment (IDE).

The FET comes with a target board, two device samples, a parallel port or USB JTAG interface box, cables and all documentation on a CD-ROM.

A CD-ROM includes both the IAR Kickstart embedded workbench IDE with 4kB C-compiler and TI Code Composer Essentials IDE with 8kB C-compiler.

The FET supports complete in-system development for all Flash based MSP430’s. Programming, assembler/C-source level debug, single stepping, multiple hardware breakpoints, full-speed operation and peripheral access are all fully supported in-system using JTAG.

The FET comes complete with everything required to complete an entire project!

Customer wishing to purchase unlimited C-compilers can do so from IAR oo TI directly.

In addition, many third parties provide tool for the MSP430 – please see www.ti.com/msp430
The 430 is very well supported including a dedicated TI website www.ti.com/msp430.
The most current MSP430 documentation is available at the MSP430 website.
For detailed technical information on device peripheral, TI has just updated the MSP430x1xx and MSP430x4xx User’s Guide.
Chip specific electrical and pin information is available in device-specific datasheets.
Over 100 application reports and 500+ downloadable code examples are available from the MSP430 website.
A listing of 3rd parties is provided
Any known silicon errata is available.
An FAQ system (Knowledge Base) and regional technical support phone lines also are available.
The MSP430 is designed specifically for battery-power measurement applications.

The clock system allows many low-power modes with no compromise in performance.

Because of a wide operating voltage range, the MSP430 can often be powered directly from a battery.

The MSP430 BOR implementation is truly ultra-low power, in the nA range and practical for all applications. The MSP430 BOR function is so low power that this function is always active, even in all low-power modes. This ensures the most reliable performance possible. Competitor’s BOR protection is in the uA range and not usable in ultra-low power battery powered applications, which leave the application vulnerable to BOR conditions.

The port pins have very low leakage when connected to external inputs. This is very important as many MCU’s have several uA of leakage on each port pin.

The overall MSP430 architecture including a 16-bit CPU with 16 registers and 16-bit data and address buses minimize power consuming fetches to memory. A fast vectored-interrupt structure reduces the need for wasteful CPU software flag polling.

Many intelligent hardware peripheral features are provided that allow tasks to be completed independent of the CPU and far more efficiently. These include the autoscan feature in the ADC12 and the available DMA. With the intelligent peripherals, the CPU does not need to be over clocked to deliver the required system performance.

Always review manufactures worst case or maximum values. Many specifications are dramatically effected over temperature.