

# ***EFM32 Presentation***

## ***February 2013***



***Frank Roberts***  
***Field Applications Director – Americas***  
***[f.roberts@energymicro.com](mailto:f.roberts@energymicro.com)***  
***720 839 7864***



# ***EFM32***

*...the world's most energy friendly microcontrollers*



# The EFM32 lineup



7-Mar-13

# Comparing the EFM32 performance

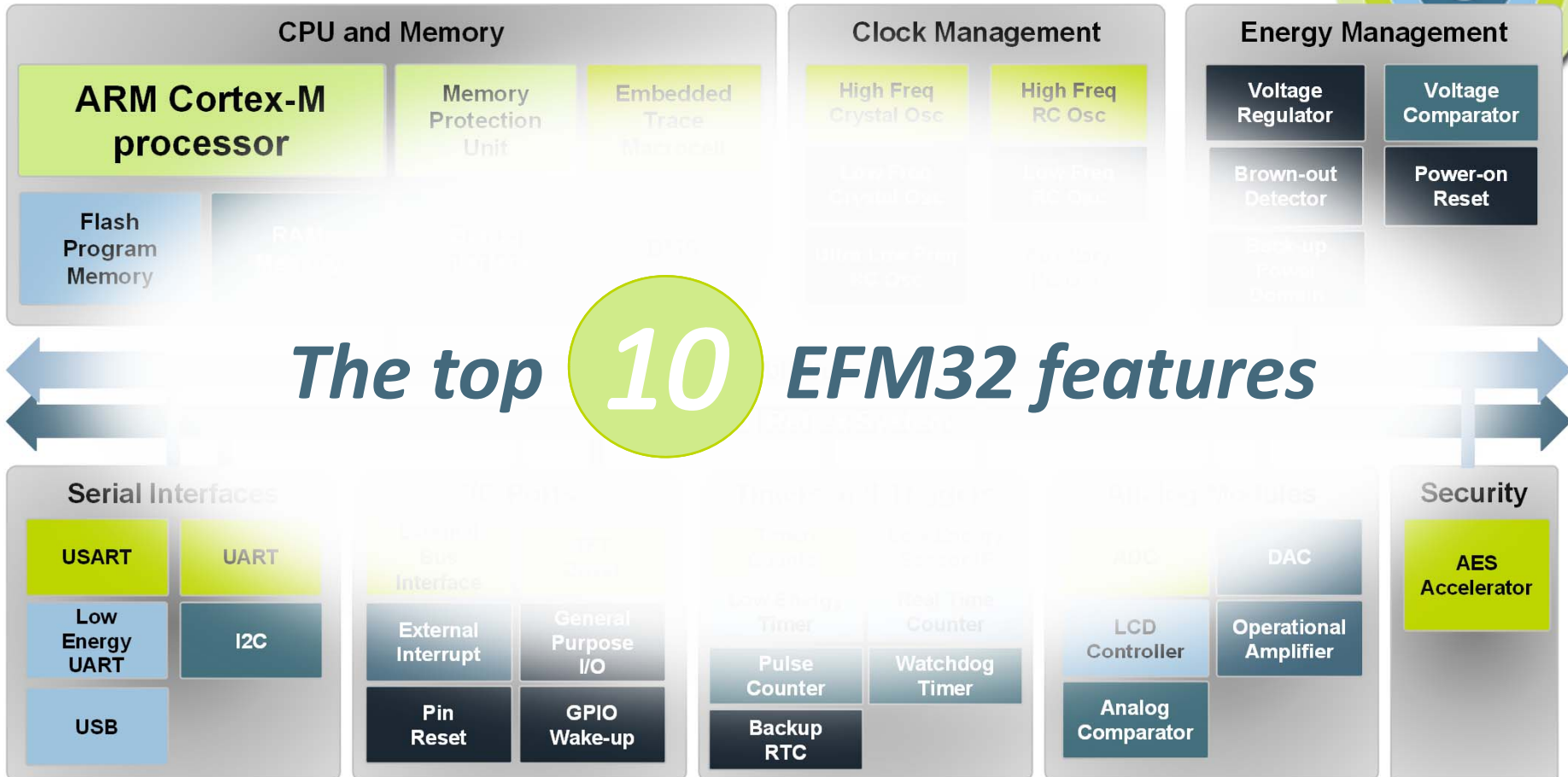


	1 Active 25 MHz @ 3V	2 Reduced processing time	3 Very fast wake-up time	4 Ultra low stand-by current	5 Autonomous peripherals	6 Peripheral Reflex System	7 Well architected Energy Modes	8 Ultra Energy Efficient Peripherals	9 Low Energy Sensor Interface	10 Advanced Energy Monitoring
32-bit EFM32TG840F32	150 $\mu\text{A}/\text{MHz}$	1 Cortex M3	2 $\mu\text{s}$	0.9 $\mu\text{A}$	Yes	Yes	Yes	Yes	Yes	Yes
32-bit STM32L151xx	294 $\mu\text{A}/\text{MHz}$	1 Cortex M3	8 $\mu\text{s}$	4.5 $\mu\text{A}$ (1.9 $\mu\text{A}^*$ )	No	No	Partial	No	No	No
32-bit SAM4Lx	218 $\mu\text{A}/\text{MHz}$	1 Cortex M4	5 $\mu\text{s}$ (1.5 $\mu\text{s}^{**}$ )	50.3 $\mu\text{A}$ (6.9 $\mu\text{A}^*$ )	Partial	Yes	Partial	No	No	No
32-bit LPC11xxL	150 $\mu\text{A}/\text{MHz}$	1.4 Cortex M0	TBD	57 $\mu\text{A}$ (6 $\mu\text{A}^*$ )	No	No	No	No	No	No
16-bit MSP430F543x	226 $\mu\text{A}/\text{MHz}$	4.3 MSP430	5 $\mu\text{s}$	2.6 $\mu\text{A}$	Partial	No	Partial	No	No	No
16-bit PIC24F16KA102	344 $\mu\text{A}/\text{MHz}$	2.3 PIC24	1 $\mu\text{s}$ (1 ms for PLL)	0.93 $\mu\text{A}$ (0.85 $\mu\text{A}^*$ )	No	No	Partial	No	No	No

7-Mar-13

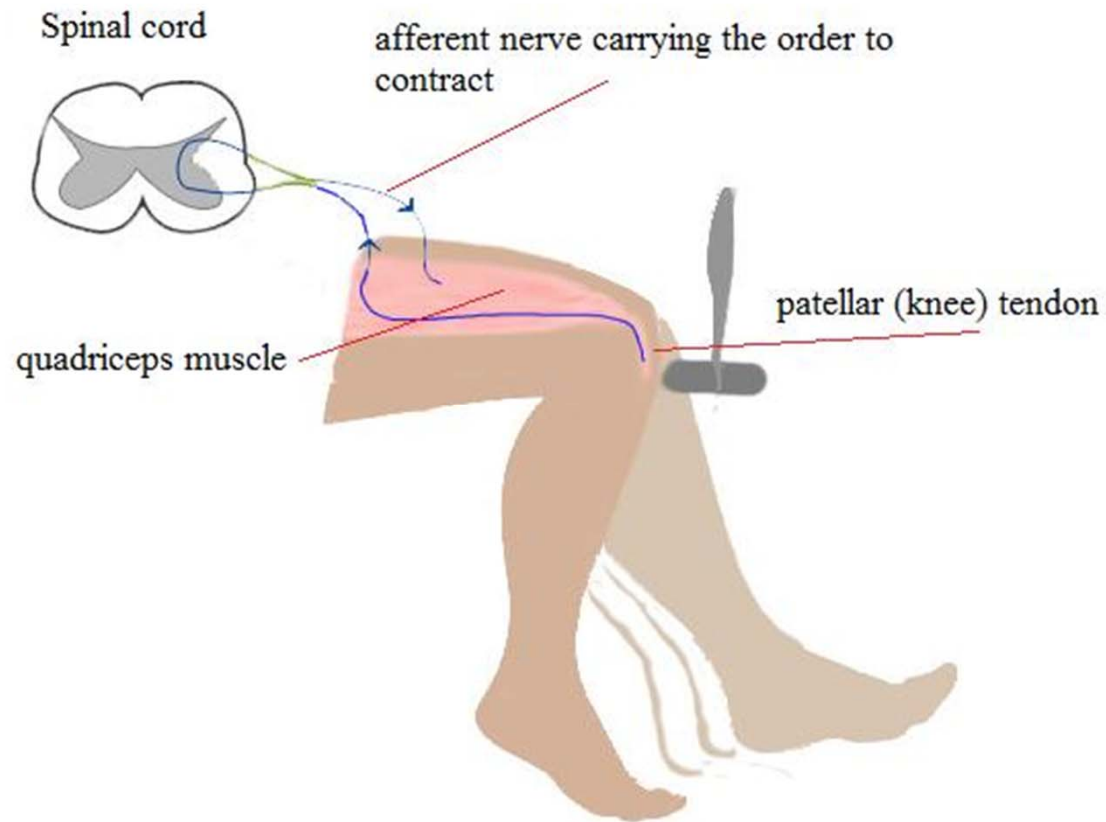
\* Brown-out detection disabled    \*\* Added consumption in active mode

# EFM32 – packed with features

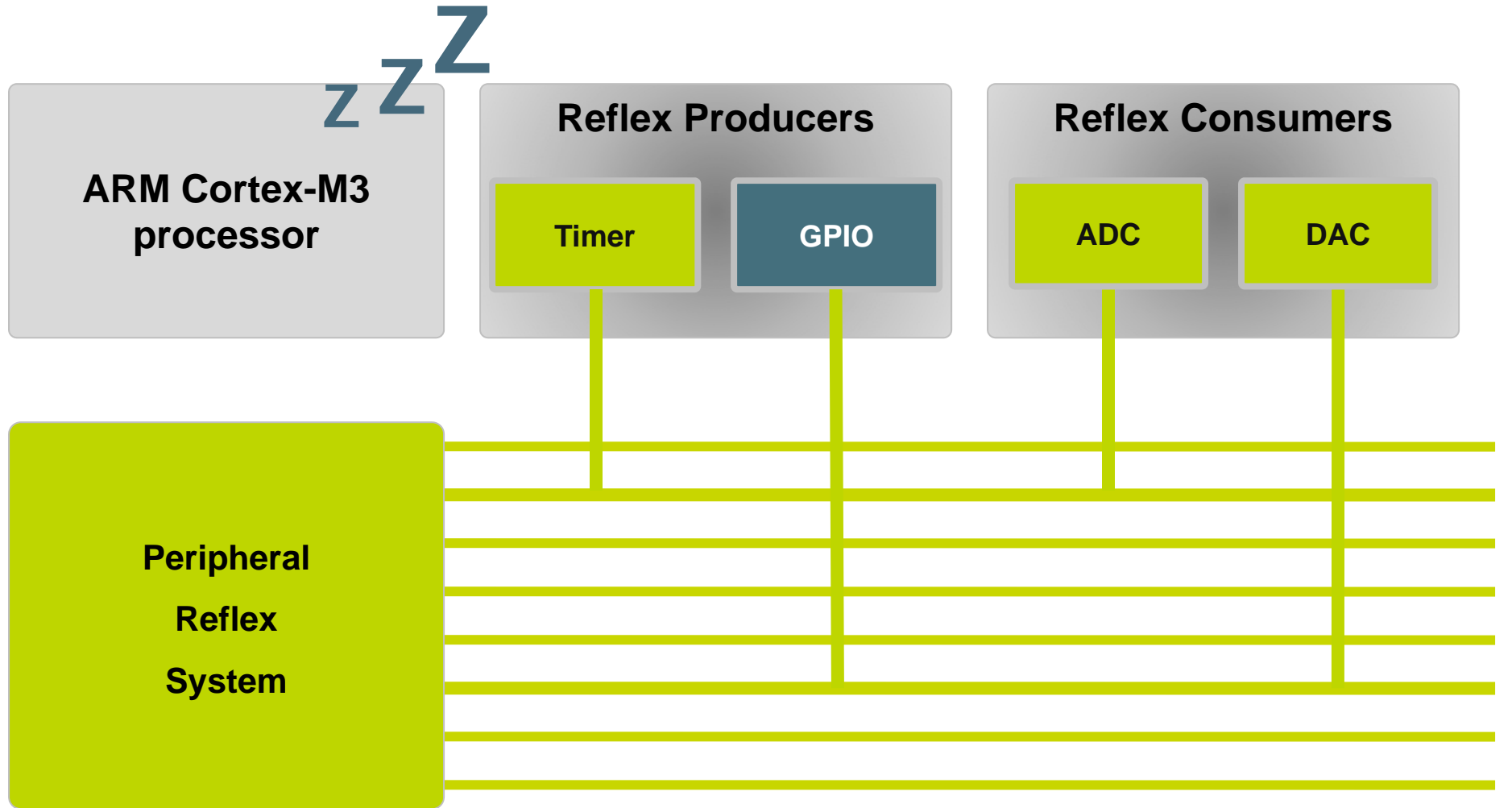


10

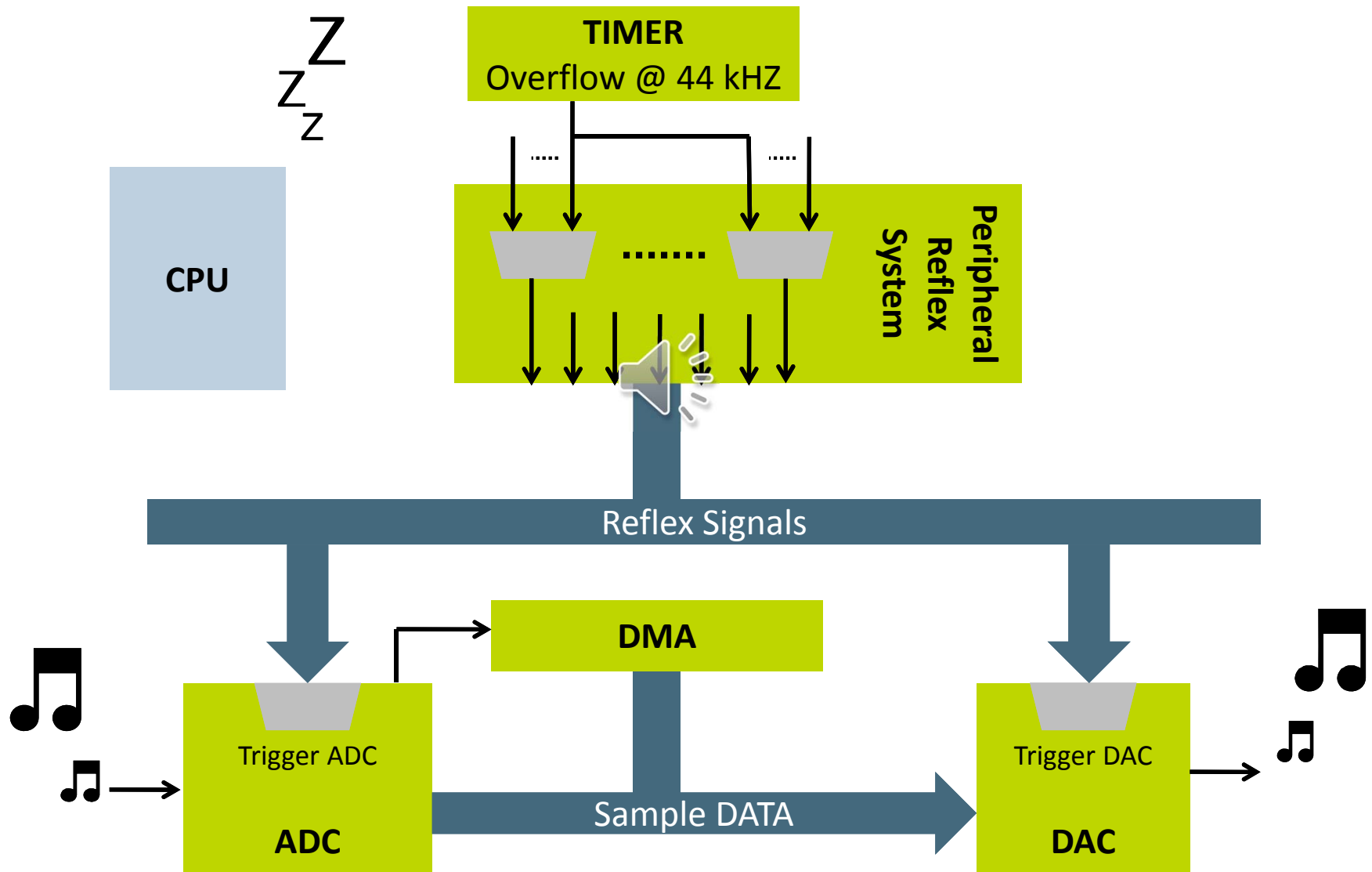
# *Peripheral Reflex System*



# Peripheral Reflex System



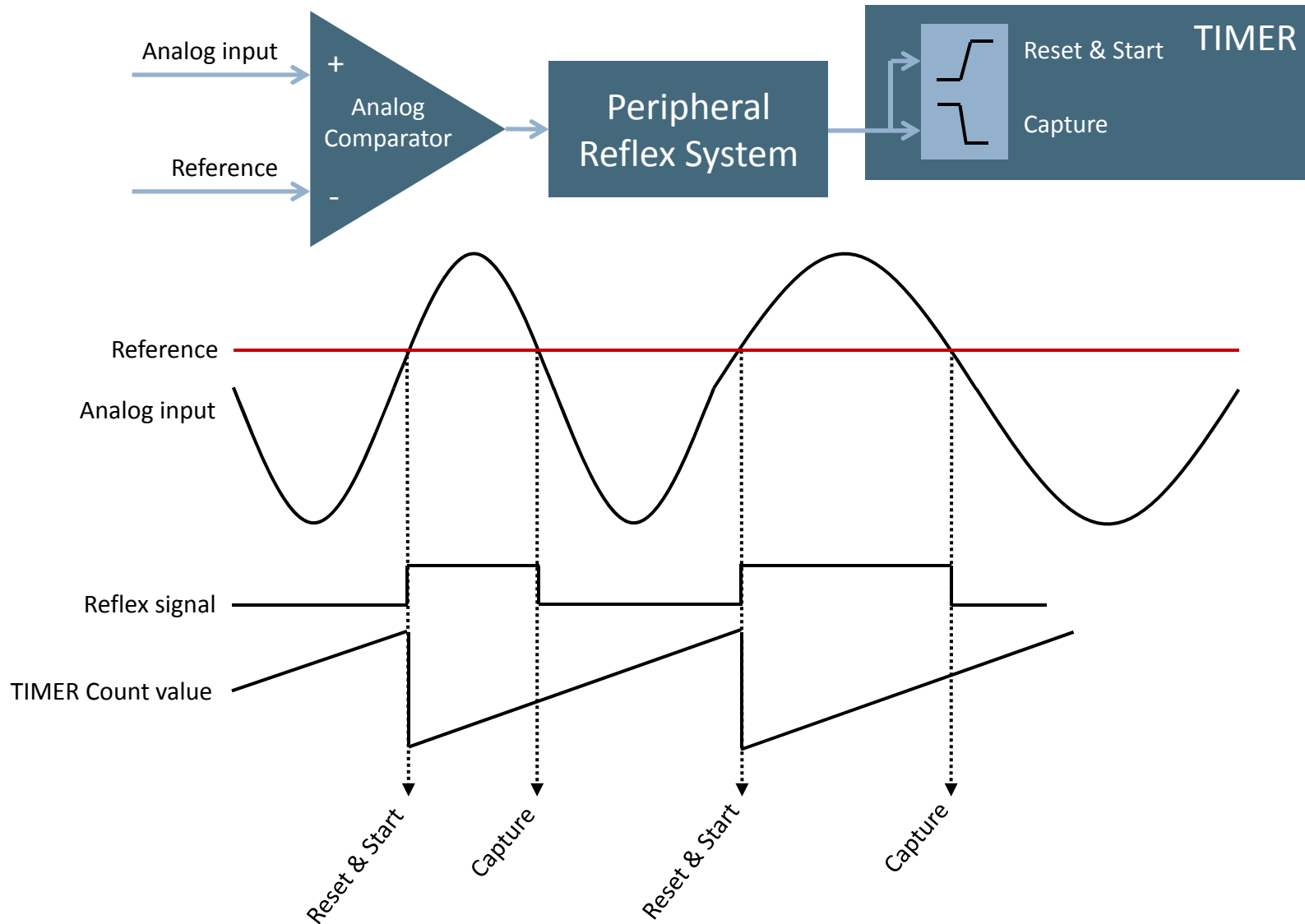
# Example – Autonomous Sound Loopback



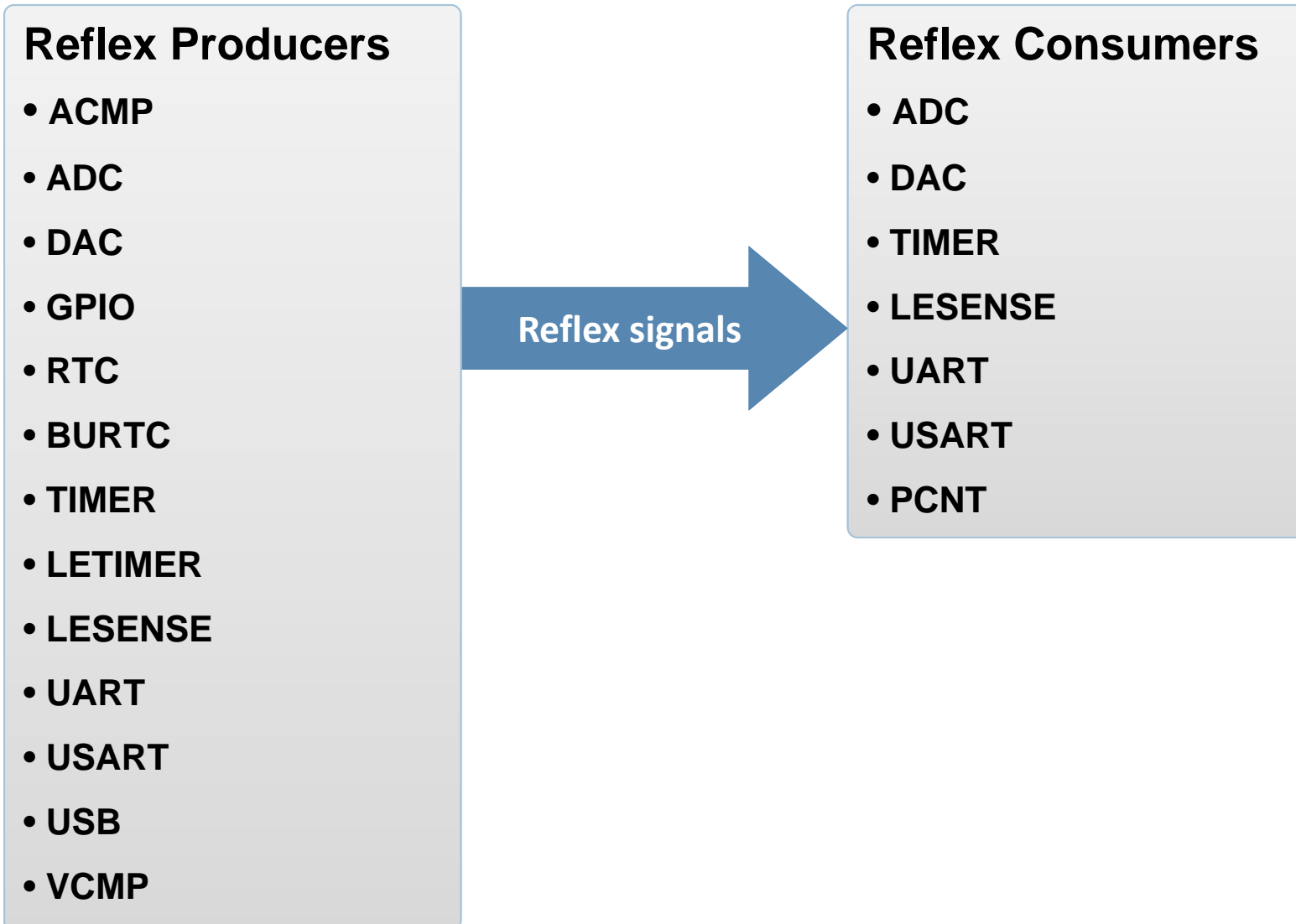
7-Mar-13



# Example: Pulse length measurement

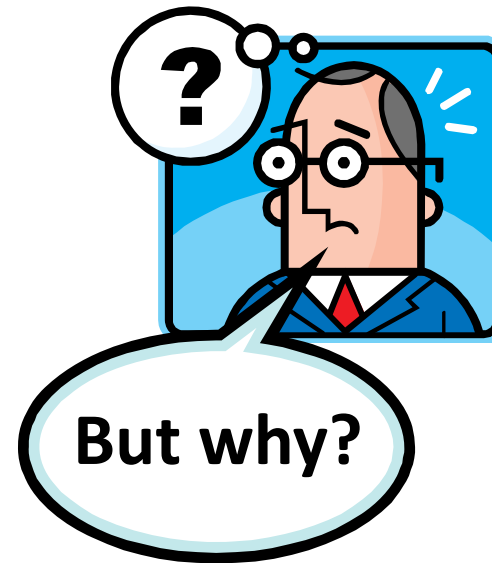


# Highly Flexible



## Reflex System – Key Benefits

- Save energy by letting peripherals communicate directly while CPU is sleeping
- Predicable timing
- Highly configurable



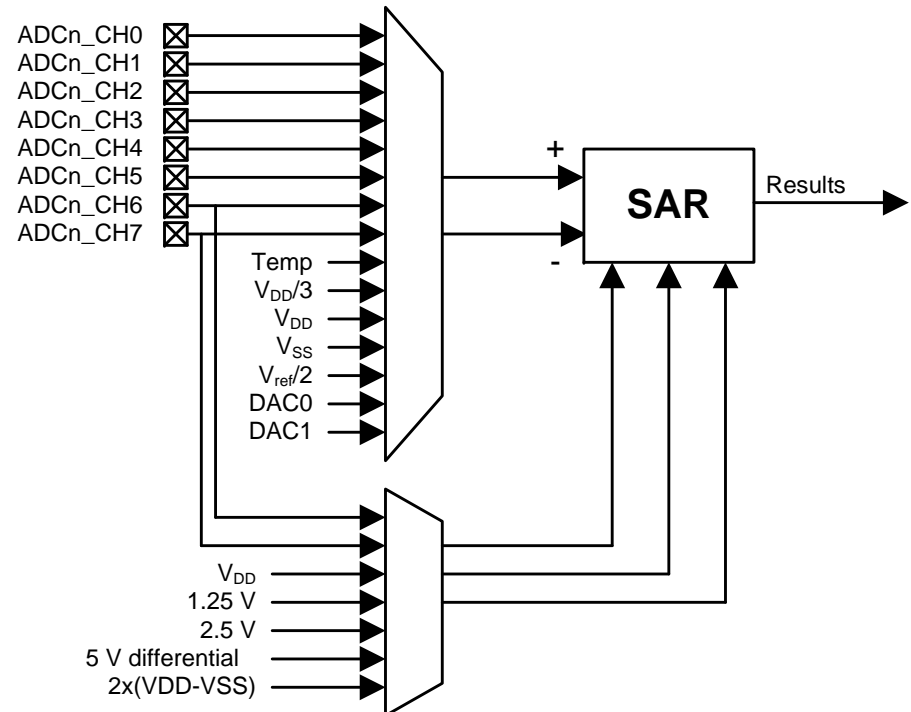
9

# *Analog to Digital Converter*

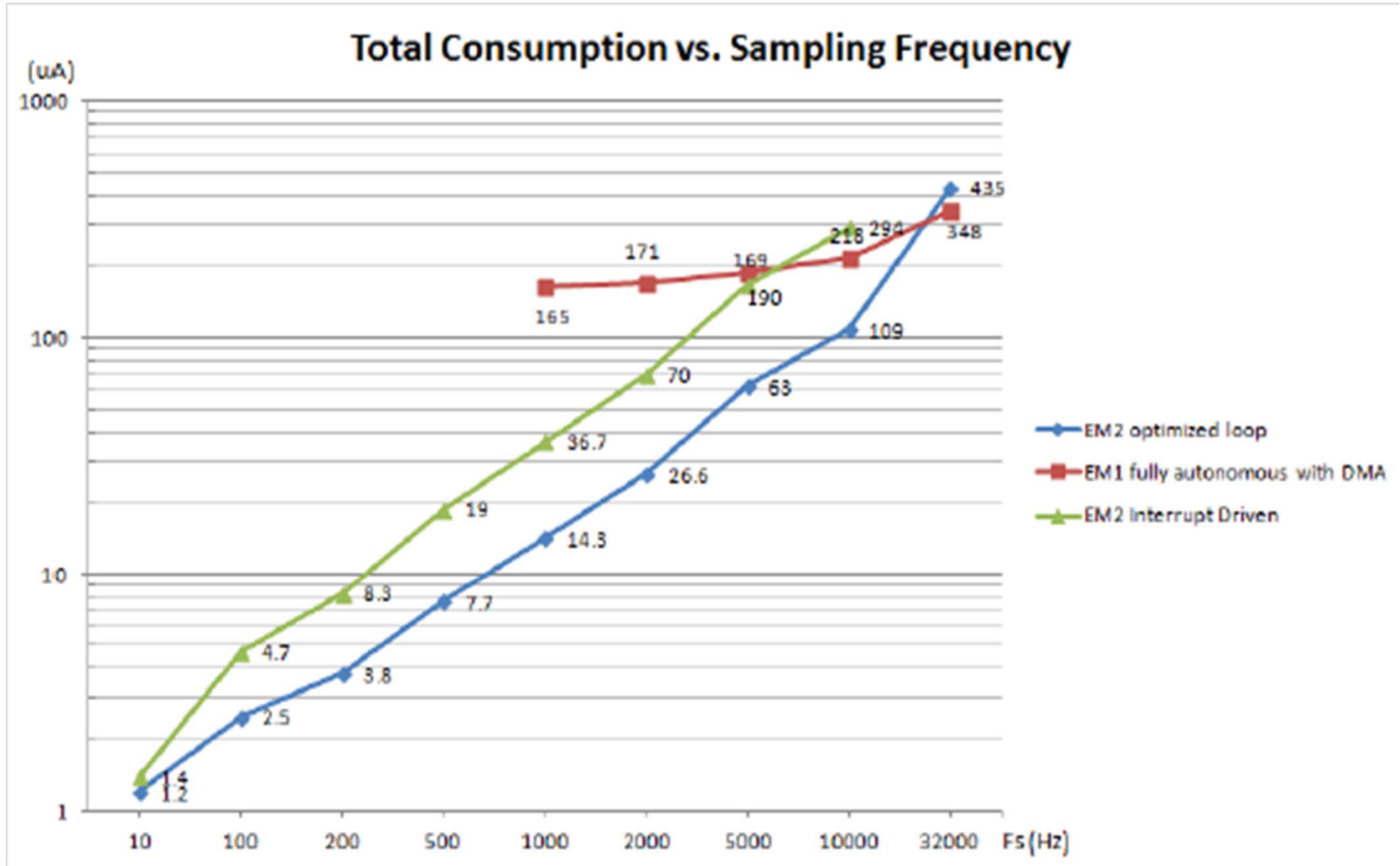
# Analog to Digital Converter

## ADC Highlights

- **12-bit @ 1 Msps: 350  $\mu$ A**
- **12-bit @ 10 ksps: 63  $\mu$ A**
- **Scalable resolution: 16,12,8 or 6 bits**
- **Up to 8 input channels**
  - **Integrated temperature sensor**
- **Internal/external references**
- **Scan/single conversions**
- **Hardware controlled warmup**
- **Tailgating**
- **Differential or Single Ended Input**



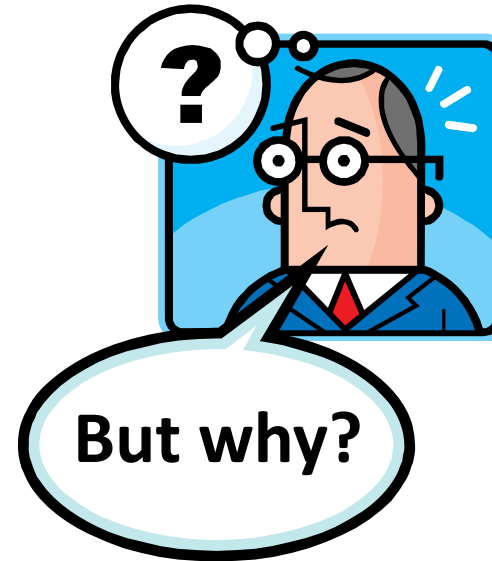
# From AN0021 ADC Appnote



7-Mar-13

## ADC – Key Benefits

- Lower total energy when sampling
- Flexible inputs and references
- Less CPU use with HW control



8



# *Flexible Display Drivers*

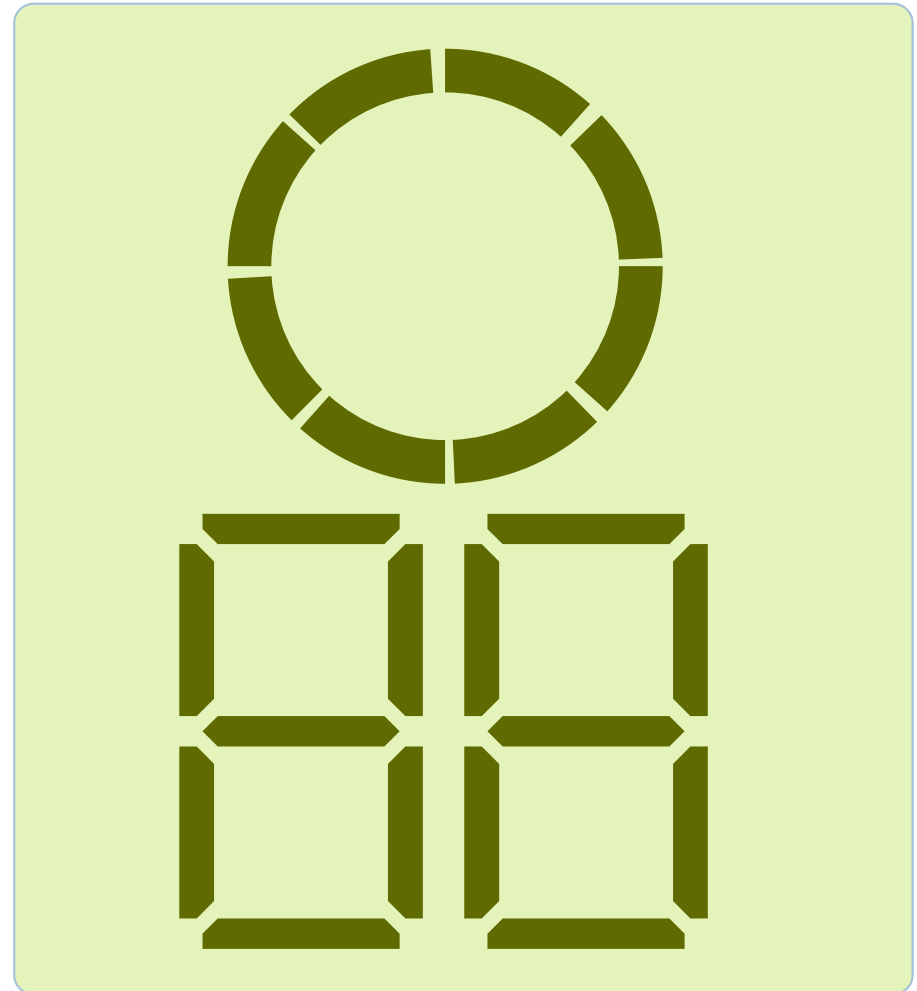




# Energy Efficient LCD Controller

## LCD Controller highlights:

- Directly driving segment LCD displays
  - G (Up to 4x40 segments)
  - TG (Up to 8x20 segments)
  - LG, GG, WG (Up to 8x36 segments)
- Energy Efficient
  - 550 nA for 4x40
  - 250 nA for 1x40
- Configurable:
  - Contrast
  - Segment blink/ Animation
- Integrated voltage booster



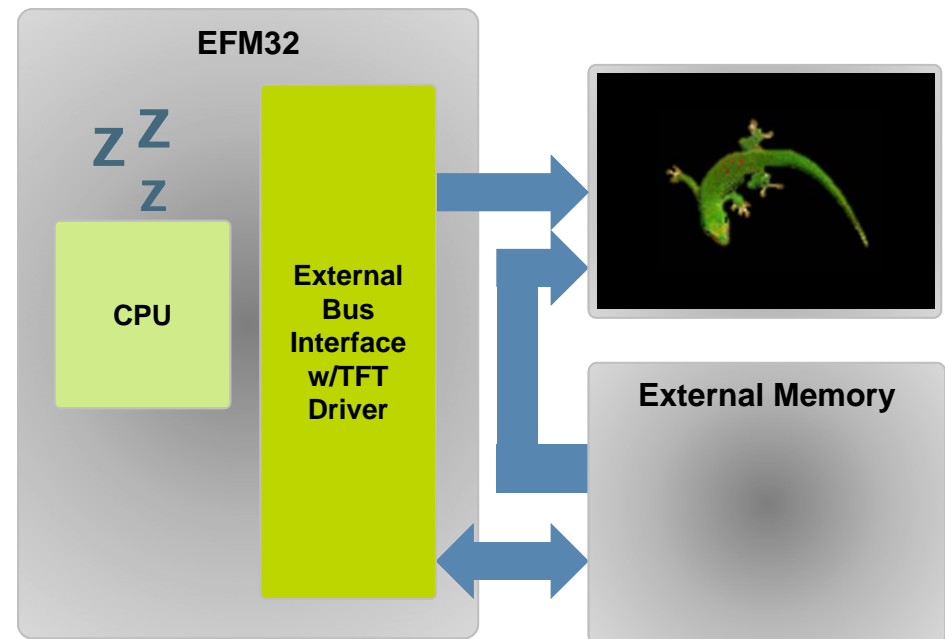
# TFT Driver



FREE Segger  
emWin Library!!

## TFT Driver Highlights

- TFT/(AM)OLED displays
  - Up to 16-bit color
- Full video from external memory
  - 0% CPU load
  - 320x240 pixels (QVGA) @ 60 fps
  - 480x320 pixels (HVGA) @ 30 fps
- Supports displays without internal frame buffer
- Accelerated graphics update
  - Scrolling
  - Rectangle copy
  - Alpha blending
  - Bit masking

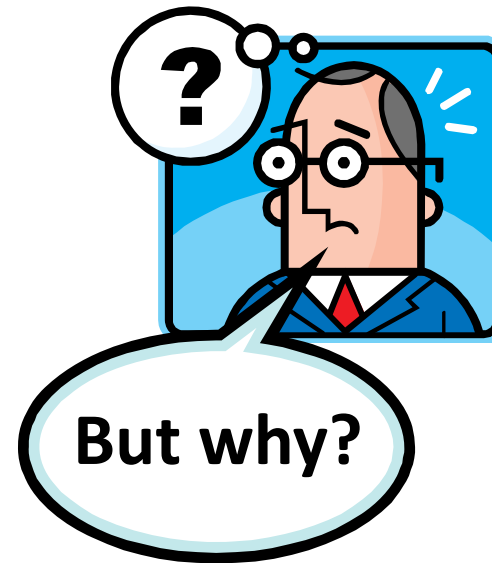


7-Mar-13



## Display Drivers – Key Benefits

- Save energy when driving LCDs
- Full QVGA TFT animations with 0% CPU load
- Save cost with TFT displays without buffer



7



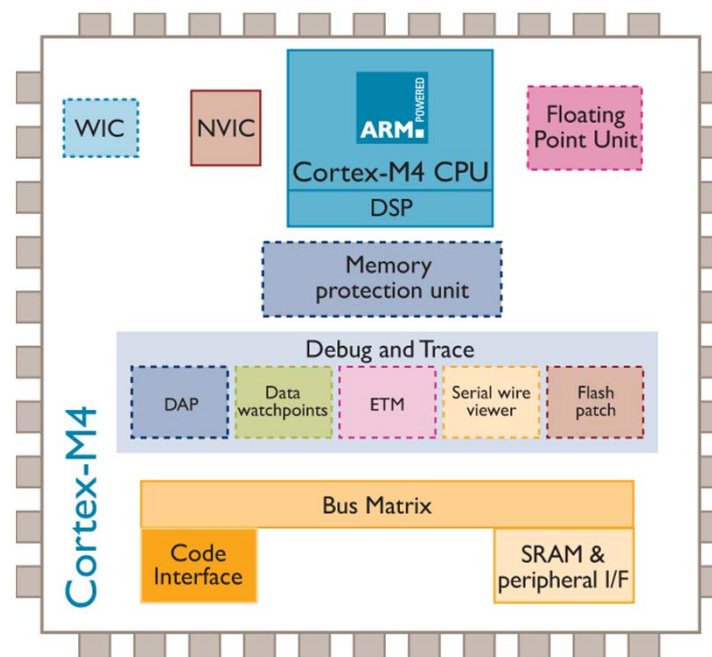
*Wide Cortex-M Portfolio*  
*WITH*  
*Energy Friendliness*

ARM Cortex-M0

ARM Cortex-M3

ARM Cortex-M4F

# ARM Cortex-M Processors



## Cortex-M highlights

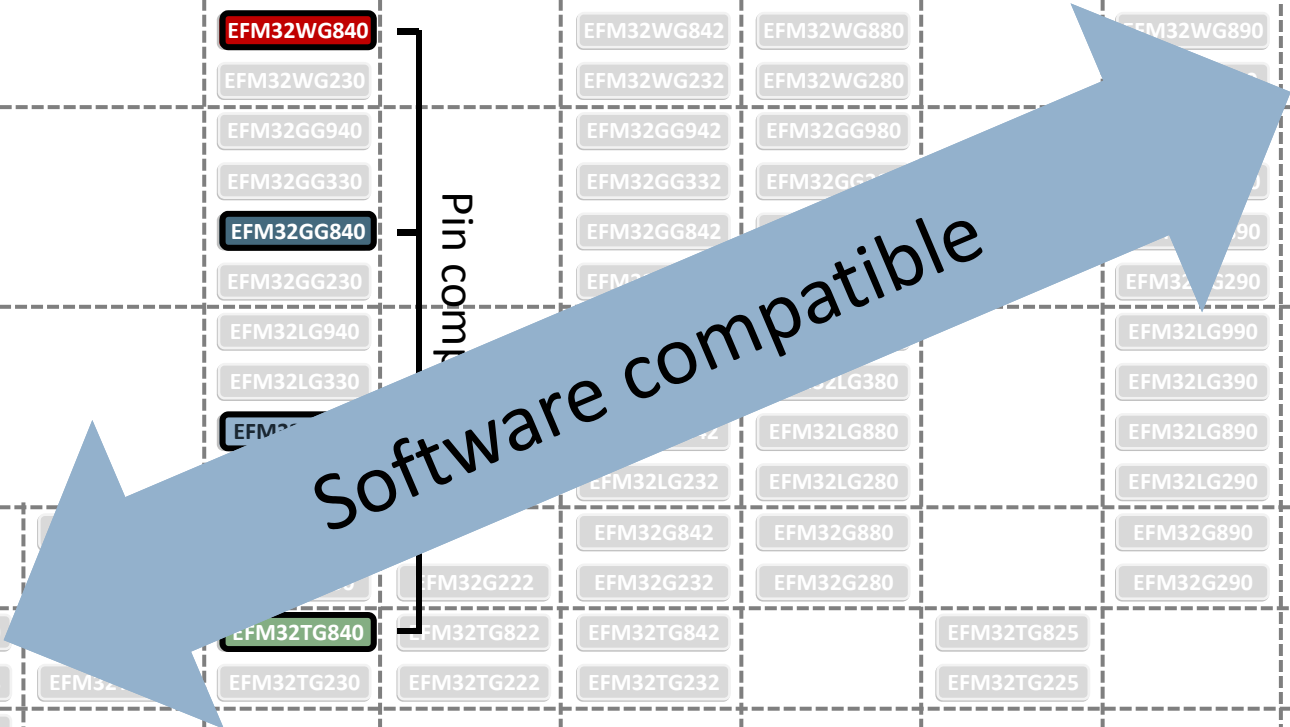
- Industry standard CPU
- Software/tool compatible across M0/M3/M4F
- High performance, low power platform
  - Up to 2.19 CoreMark/MHz
  - As little as 150  $\mu$ A/MHz in EFM32
- Excellent code density
- DSP options in M4F

# 240+ Scalable Low Energy EFM32s



- Software compatible
- Pin compatibility within each package

MCU Family	Package	Optional Features	QFN24	QFN32	QFN64	QFP48	QFP64	QFP100	BGA48	BGA112	BGA120
M4F	Wonder	USB LCD TFT DSP with FPU			EFM32WG940		EFM32WG942	EFM32WG980		EFM32WG990	EFM32WG995
					EFM32WG330		EFM32WG332	EFM32WG380		EFM32WG390	EFM32WG395
					<b>EFM32WG840</b>	Pin compatible	EFM32WG842	EFM32WG880		EFM32WG890	EFM32WG895
					EFM32WG230		EFM32WG232	EFM32WG280		EFM32WG290	EFM32WG295
		EFM32GG940	EFM32GG942	EFM32GG980			EFM32GG990	EFM32GG995			
		EFM32GG330	EFM32GG332	EFM32GG380			EFM32GG390	EFM32GG395			
M3	Giant	USB LCD TFT			<b>EFM32GG840</b>		EFM32GG842	EFM32GG880		EFM32GG890	EFM32GG895
					EFM32GG230	EFM32GG232	EFM32GG280		EFM32GG290	EFM32GG295	
					EFM32LG940	EFM32LG942	EFM32LG980		EFM32LG990	EFM32LG995	
					EFM32LG330	EFM32LG332	EFM32LG380		EFM32LG390	EFM32LG395	
M3	Leopard	USB LCD TFT			<b>EFM32LG840</b>		EFM32LG842	EFM32LG880		EFM32LG890	EFM32LG895
					EFM32LG230	EFM32LG232	EFM32LG280		EFM32LG290	EFM32LG295	
					EFM32G840	EFM32G842	EFM32G880		EFM32G890		
					EFM32G222	EFM32G232	EFM32G280		EFM32G290		
M0	Tiny	LCD	EFM32TG110		<b>EFM32TG840</b>	EFM32TG822	EFM32TG842		EFM32TG825		
			EFM32TG108	EFM32TG108	EFM32TG230	EFM32TG222	EFM32TG232		EFM32TG225		
			EFM32ZG110								
			EFM32ZG108	EFM32ZG108	EFM32ZG210	EFM32ZG222					



Total 16 MCUs  
Flash: 4 - 32  
RAM: 2 - 4



Total 35 MCUs  
Flash: 4 - 32  
RAM: 2 - 4



Total 31 MCUs  
Flash: 16 - 128  
RAM: 8 - 16



Total 60 MCUs  
Flash: 64 - 256  
RAM: 32



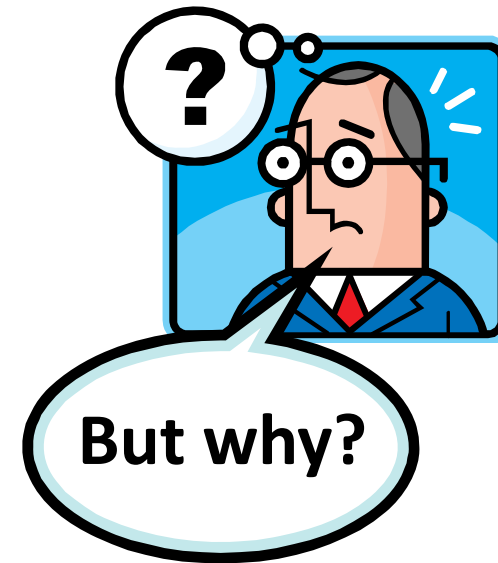
Total 40 MCUs  
Flash: 512 - 1024  
RAM: 128



Total 60 MCUs  
Flash: 64 - 256  
RAM: 32

## Cortex-M Portfolio– Key Benefits

- Industry standard CPU
- Wide Cortex-M scalability
- Pin/SW compatibility across families
- Energy friendly MCU with up to 1 MB/128 KB memory



6



# *Well Architected Energy Modes*



# Well Architected Energy Modes

EM0 “Run Mode”: **150 $\mu$ A/MHz**

EM1 “Sleep Mode”: **45 $\mu$ A/MHz**

EM2 “Deep Sleep Mode”: **900nA**

*RTC, Brown-Out Detection, RAM and CPU retained  
2  $\mu$ s wake-up*

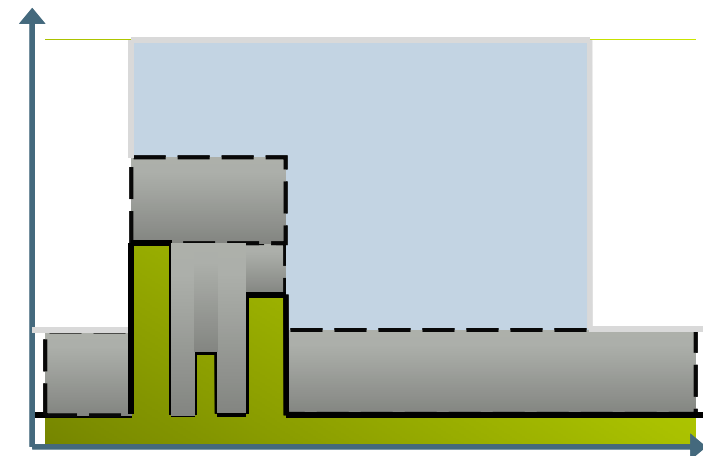
EM3 “Stop Mode”: **600nA**

*Brown-Out Detection, RAM & CPU retained  
2  $\mu$ s wake-up*

EM4 “Shutoff Mode”: **20nA**

*Pin/GPIO Reset*

*RTC + 512-byte backup memory : **400 nA***



***EFM32 Peripherals can be used in Ultra Low Power EM2 and EM3: For example DMA can be used in EM2 Mode with the MCU in a 900nA mode!!***

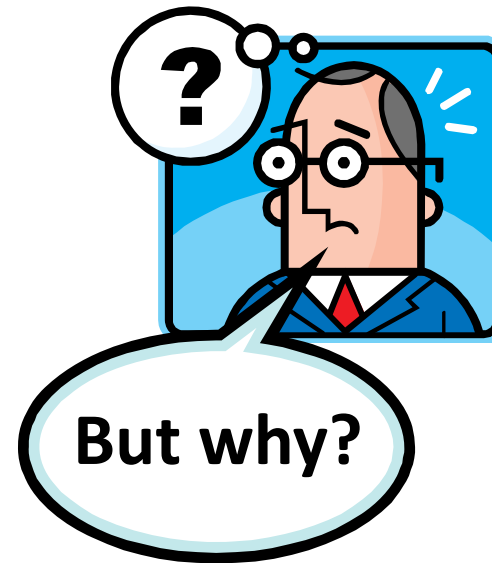
**Table 10.1. EMU Energy Mode Overview**

	EM0 <sup>1</sup>	EM1 <sup>2</sup>	EM2 <sup>2</sup>	EM3 <sup>2</sup>	EM4 <sup>2</sup>
Wakeup time to EM0	-	-	2 $\mu$ s	2 $\mu$ s	160 $\mu$ s
MCU clock tree	On	-	-	-	-
High frequency peripheral clock trees	On	On	-	-	-
Core voltage regulator	On	On	-	-	-
High frequency oscillator	On	On	-	-	-
I <sup>2</sup> C full functionality	On	On	-	-	-
Low frequency peripheral clock trees	On	On	On	-	-
Low frequency oscillator	On	On	On	-	-
Real Time Counter	On	On	On	-	-
LCD	On	On	On	-	-
LEUART	On	On	On	-	-
LETIMER	On	On	On	-	-
PCNT	On	On	On	-	-
ACMP	On	On	On	On	-
I <sup>2</sup> C receive address recognition	On	On	On	On	-
Watchdog	On	On	On	On <sup>3</sup>	-
Pin interrupts	On	On	On	On	-
RAM voltage regulator/RAM retention	On	On	On	On	-
Brown Out Reset	On	On	On	On	-
Power On Reset	On	On	On	On	On
Pin Reset	On	On	On	On	On
GPIO state retention	On	On	On	On	On <sup>4</sup>
EM4 Reset Wakeup Request	-	-	-	-	On <sup>4</sup>
EM4 Reset Wakeup Request	-	-	-	-	On

7-Mar-13

## Energy Modes– Key Benefits

- Low power consumption
- A lot of peripherals available in lower sleep modes
- 2 $\mu$ s wake-up



5

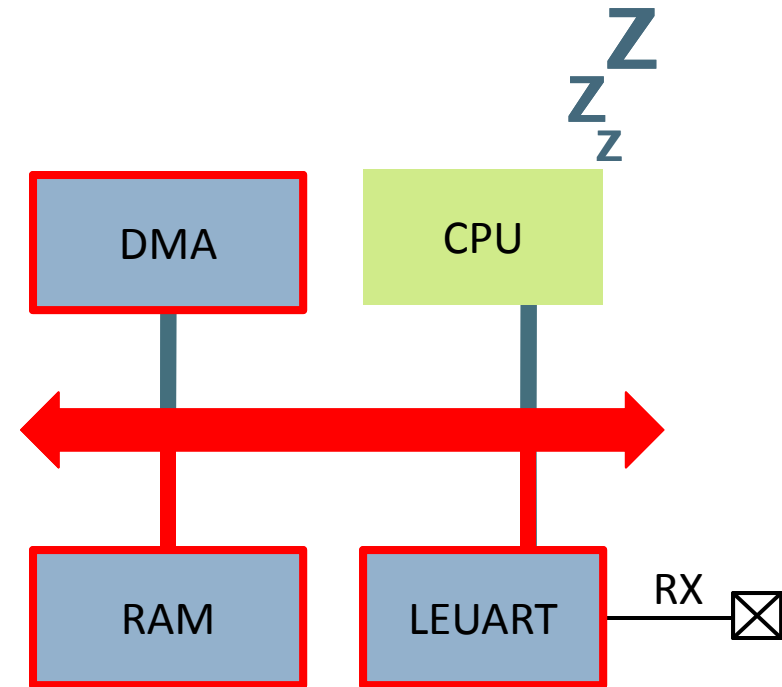


# *Low Energy UART*

# Low Energy UART

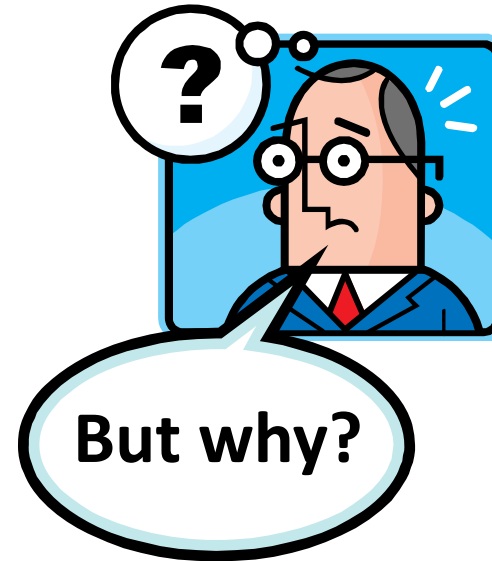
## LEUART Highlights

- Up to 2 LEUARTs
- Full UART with 32 kHz clock
- Can operate entirely in EM2(900nA) with DMA
- **150 nA at 9600 baud/s**
- DMA support
- Valid wake-up packet



## *Low Energy UART– Key Benefits*

- Stay in Deep Sleep while sending or receiving data
- Save energy by only waking up on specific data



4

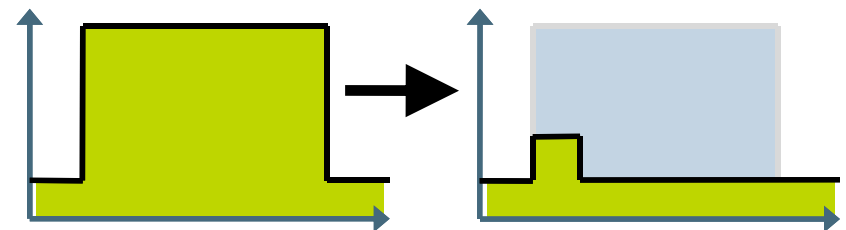
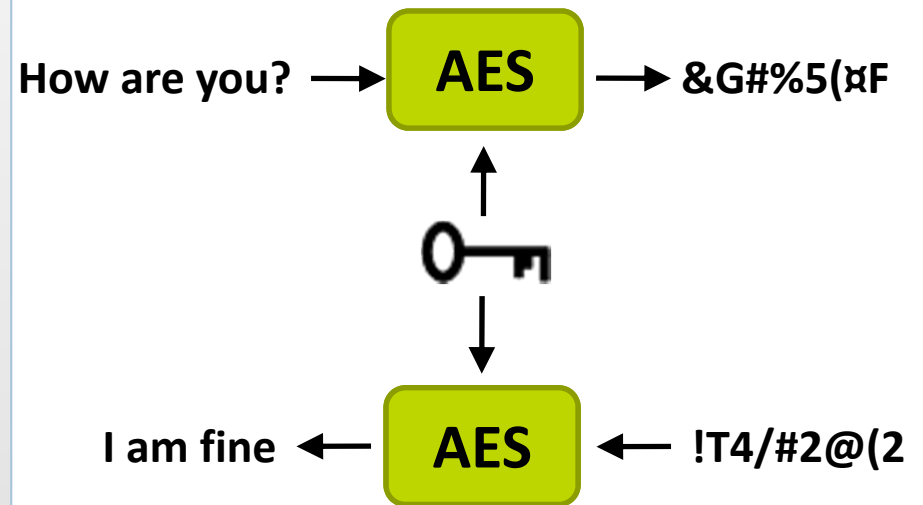


# *Hardware AES Acceleration*

# AES Encryption Accelerator

## AES Highlights

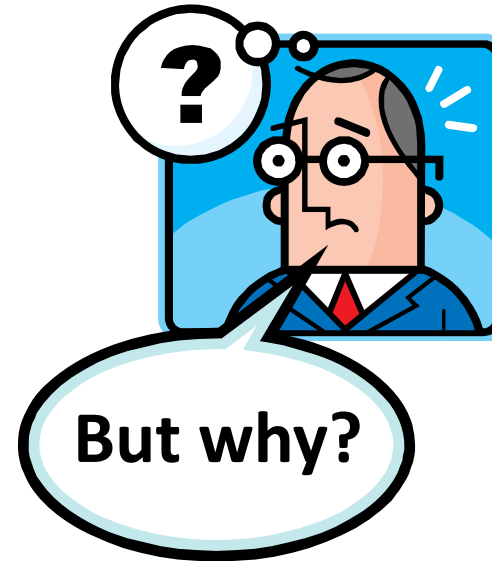
- Encryption/decryption
- 128/256-bit keys @ 54/75 cycles
- 20 – 80 times faster than software
- On-the-fly key generation
  - No memory required
- Key buffering in 128-bit mode
  - No reload of key
- DMA support for autonomous cipher modes
- **2.5uA/MHz**





## AES Accelerator – Key Benefits

- Faster encryption
- Save energy when encrypting
- Fully integrated HW saves memory



3

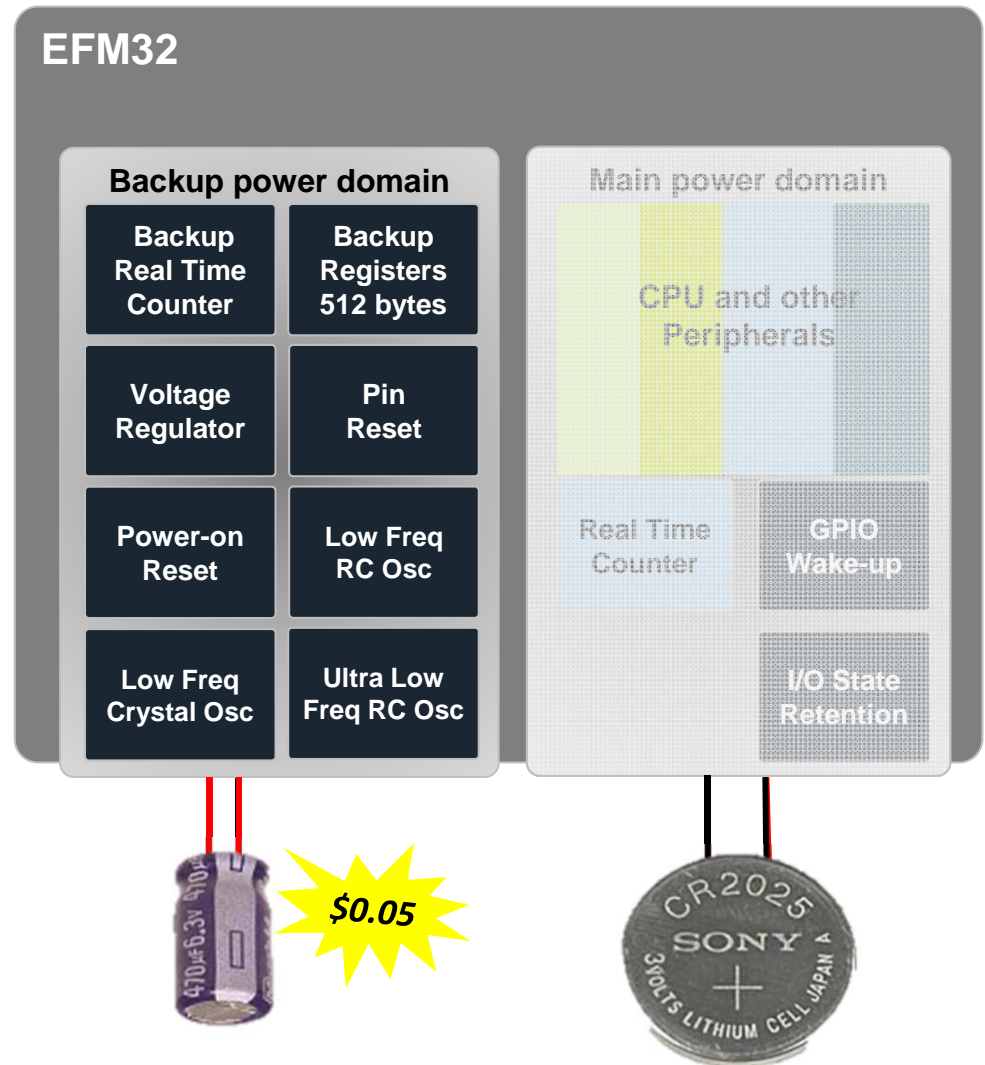


# *Back-up Power Domain*

# Backup Power Domain

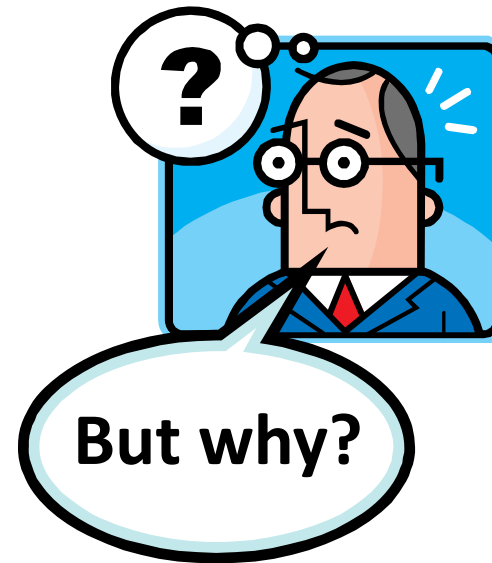
## Backup Domain Highlights

- Automatic main/backup power switch
- 32-bit Backup RTC
  - Use any LF oscillator
- 512-byte backup register
- **400nA** with RTC and registers
- AN0041 Backup RTC/Power Domain Appnote w/Source Code



## Backup Domain – Key Benefits

- Energy Friendly backup mode
- No external switches needed
- Retention of critical data at minimum energy and cost



2



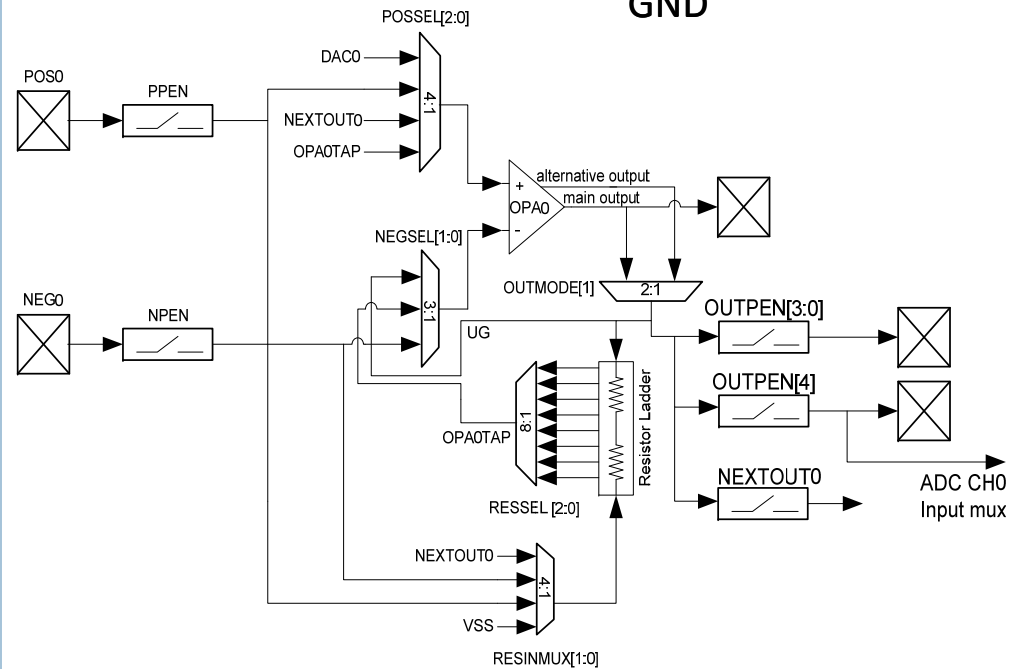
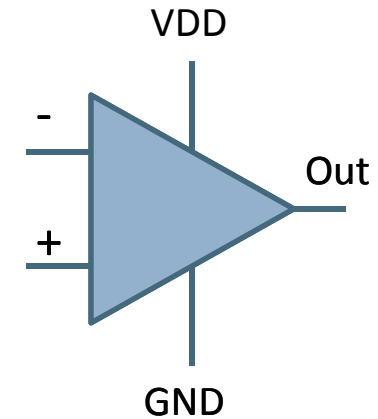
# *Integrated Operational Amplifiers*

# Operational Amplifiers



## OpAmp Highlights

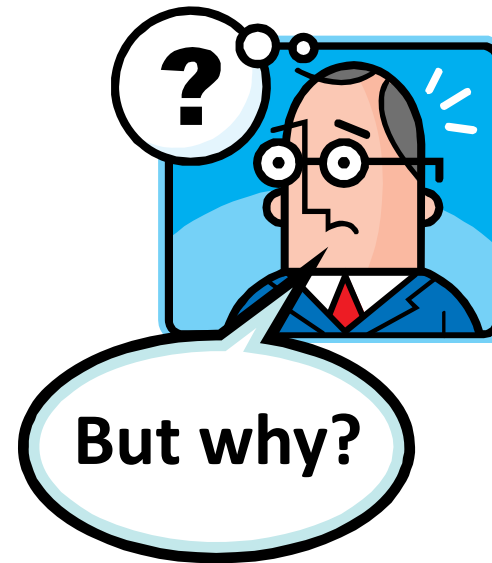
- 3 rail-to-rail OPAMPs integrated
- Inputs from pin, DAC or OPAMPs
- Outputs to pin, ADC or OPAMPs
- Various configuration modes
  - Programmable gain
  - Inverting / non-inverting
  - Cascading
  - + + +
- 6.1 MHz gain bandwidth product
- 13 – 400  $\mu\text{A}$  active current
- 65 degree phase margin
- 1 mV offset voltage



7-Mar-13

## OPAMPs– Key Benefits

- Save space
- Save cost



1



# *Low Energy Sensor Interface*



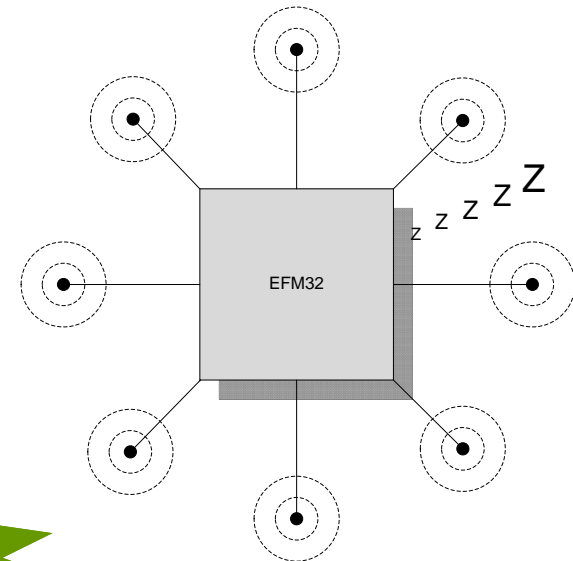


# Low Energy Sensor Interface (LESENSE)



## LESENSE Highlights

- Autonomous sensing in EM2/EM3(w/ ULFRCO)
- LESENSE with central control logic
  - ACMP for sensor input
  - DAC for reference generation
- Measure up to 16 sensors
- Programmable state machine
  - 16 states, 4 input channels
  - Can do quadrature decoding
- Interrupt/PRS on sensor events



7-Mar-13



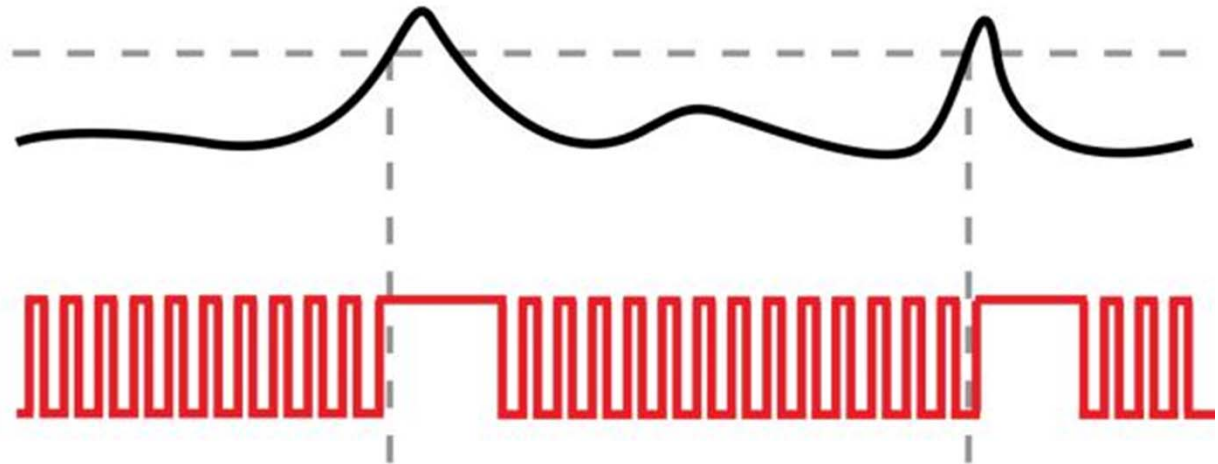
# LESENSE - Low Energy Sensor interface

## Analog events

Capacitive, inductive or resistive sensors

## Generic MCU

Wake-up periodically to detect the events



# LESENSE - Low Energy Sensor interface

## Analog events

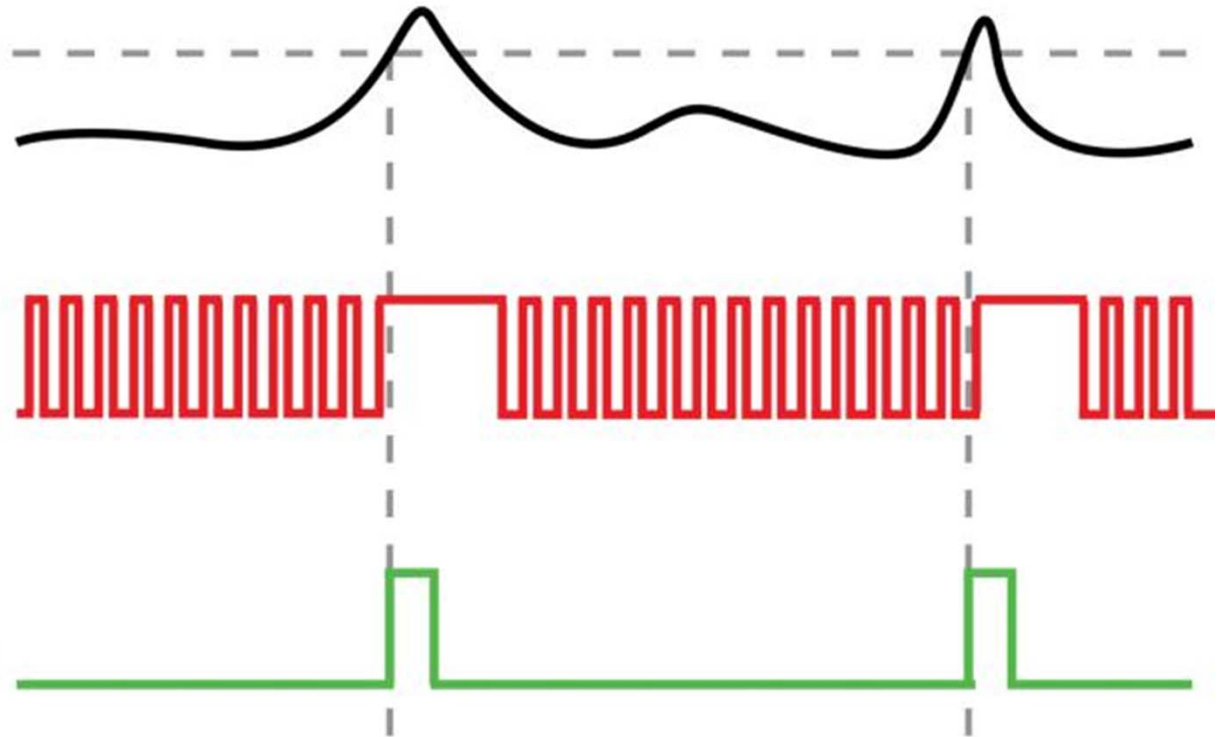
Capacitive, inductive or resistive sensors

## Generic MCU

Wake-up periodically to detect the events

## Gecko MCU

Wake-up only on the events



# LESENSE - Low Energy Sensor interface

## Analog events

Capacitive, inductive or resistive sensors

## Generic MCU

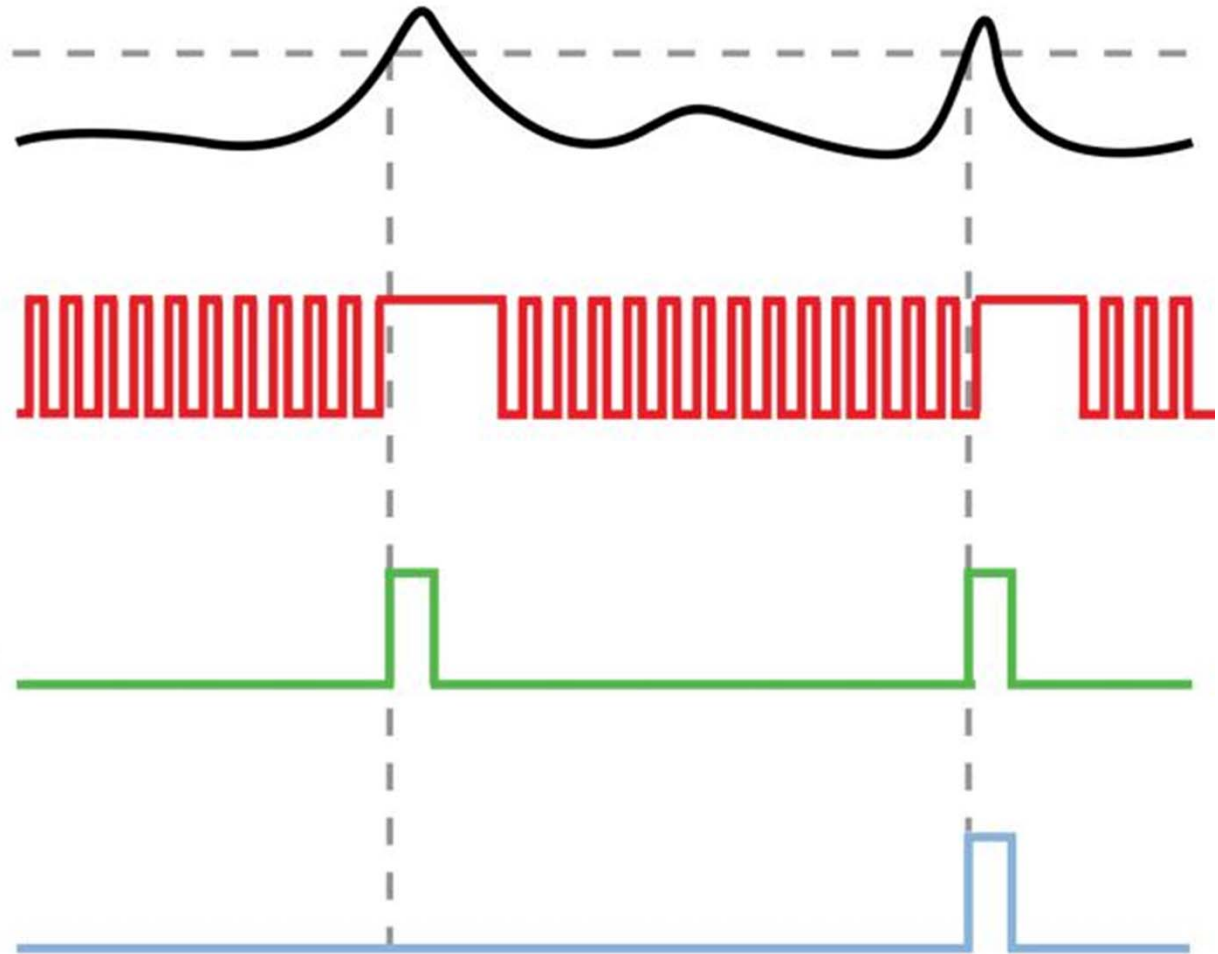
Wake-up periodically to detect the events

## Gecko MCU

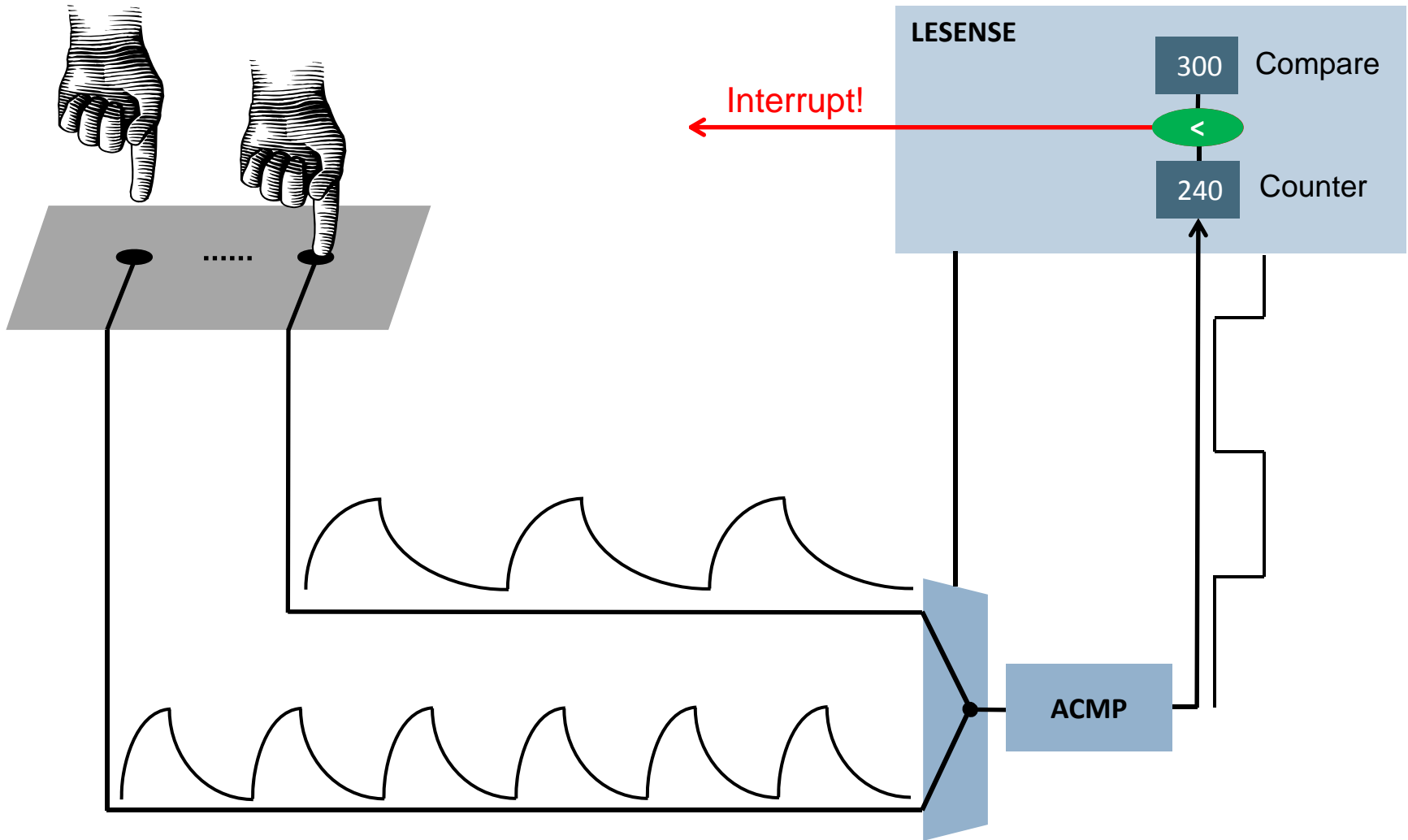
Wake-up only on the events

## Gecko MCU

Conditional wake-up  
(e.g. on every 2nd event)

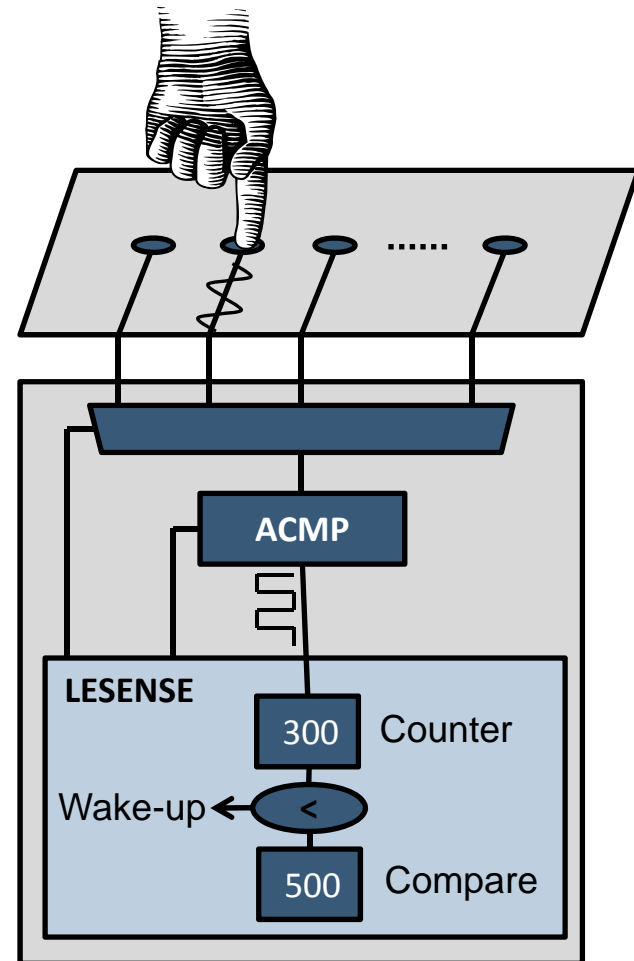


# Capacitive Measurement



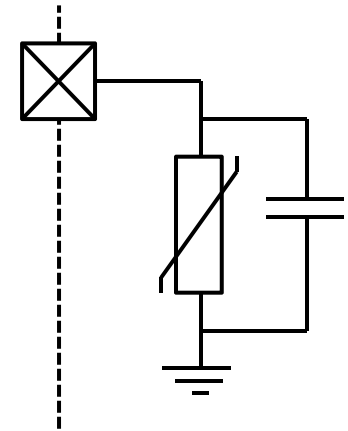
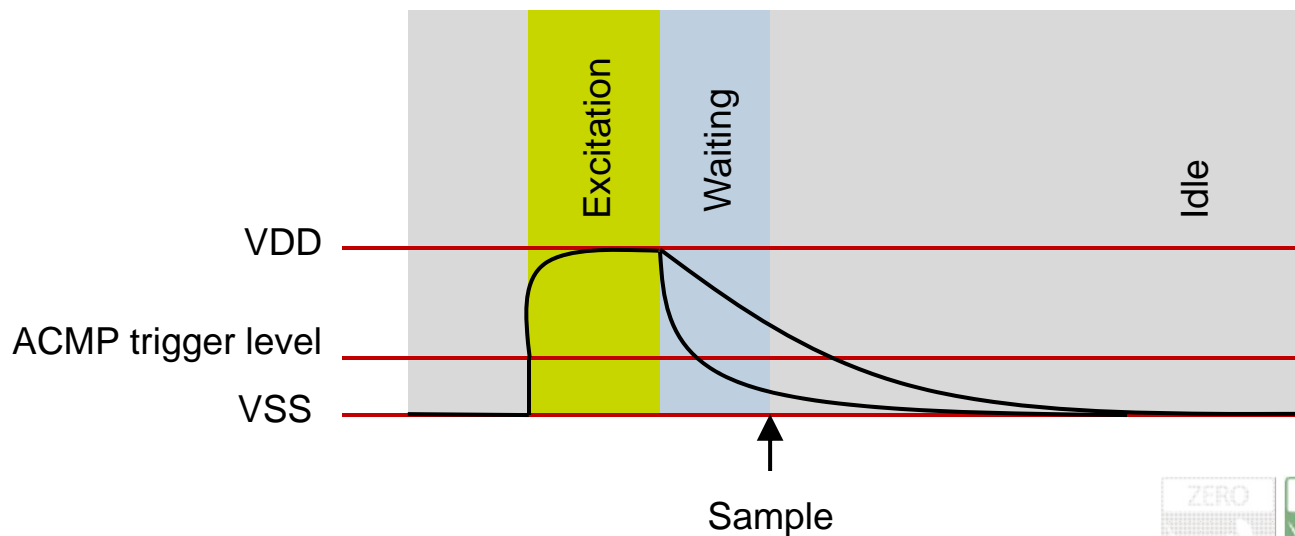
## LESENSE – Capacitive Example

- Analog Comparators measure one input at a time
- Counts oscillations for a given time period
- Touched sensor gives lower frequency
- Performs action if threshold is breached
  - Wake-up
  - State-machine input
  - Buffer results
- **1.2  $\mu\text{A}$  @ 20 Hz**



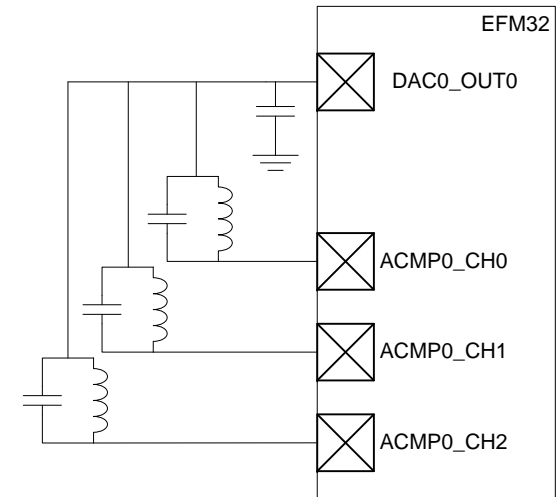
## LESENSE – Resistive Example

- Capacitor charged to VDD during excitation
- Sample ACMP output after a programmable time
  - Wake-up
  - Buffer results
  - State Machine input
- Adjustable time period before sampling



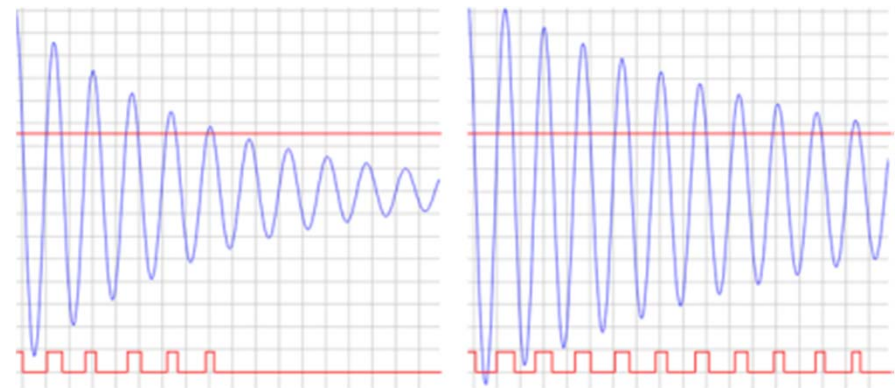
# LESENSE – Inductive Example

- DAC drives common level
- Excitation pulses individual lines low
- Oscillations damped faster when close to metal
- LESENSE counts the number of times the oscillation breaches the ACMP threshold (red)
- Action if lower than compare value
  - Wake-up
  - State machine input
  - Buffer results
- Autonomous in Deep Sleep
  - **1.4  $\mu$ A @ 20 Hz**



Metal

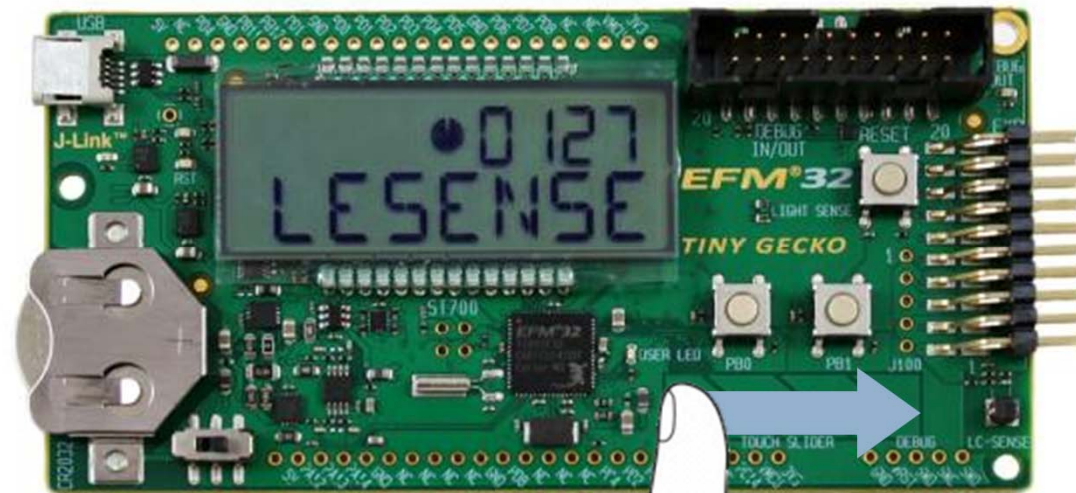
No metal





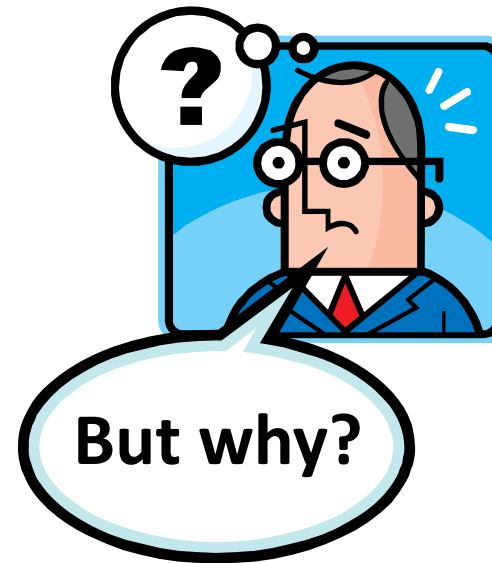
## Autonomous «slide-to-unlock»

- Use LESENSE state machine to detect order of capacitive button press
- Stay in Deep Sleep until right order is detected
- Reduce energy impact of frequent unintentional touches

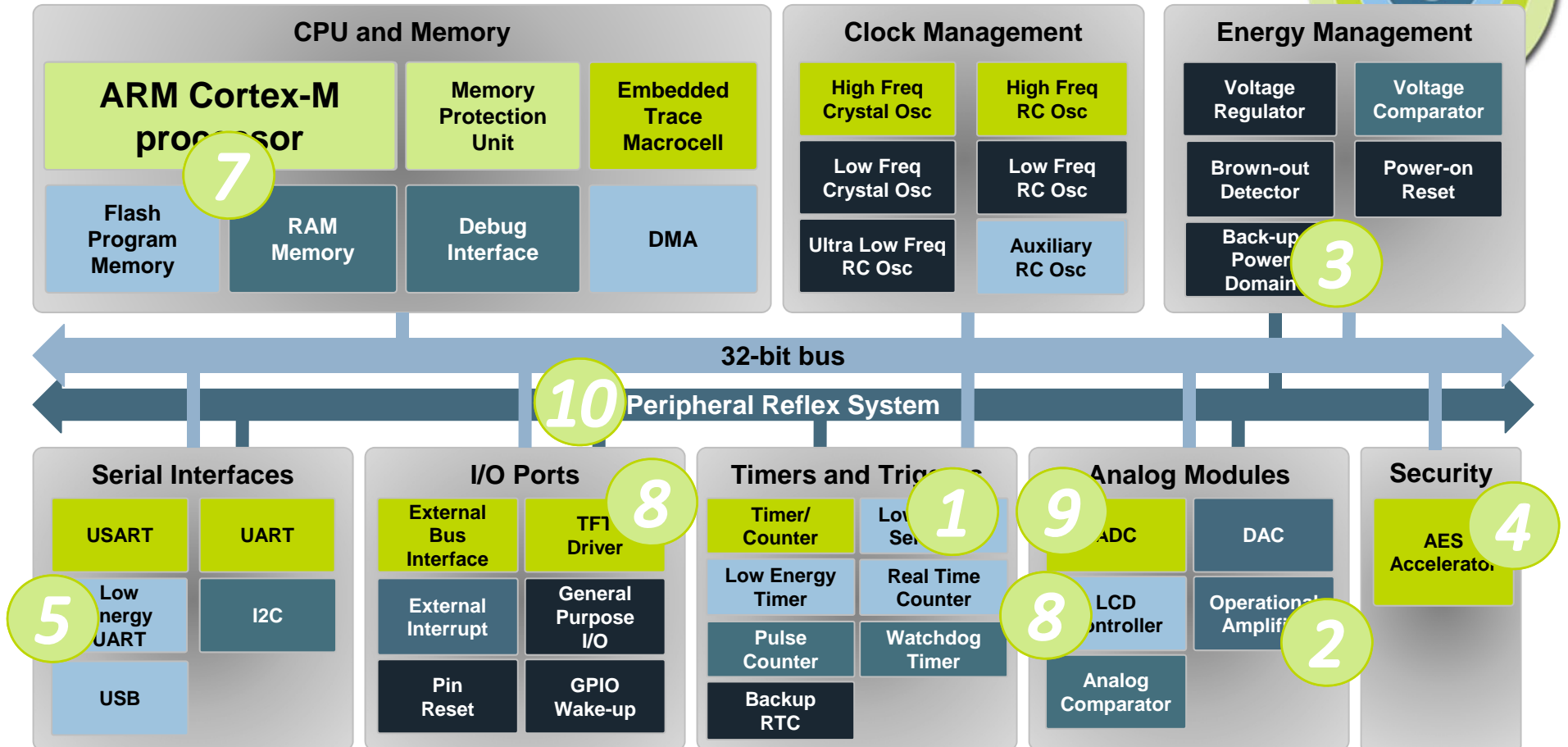


## LESENSE– Key Benefits

- Save energy by staying in Deep Sleep while monitoring sensors
- Save cost of expensive dedicated sensor ICs with wake-up functionality



# EFM32 – packed with features



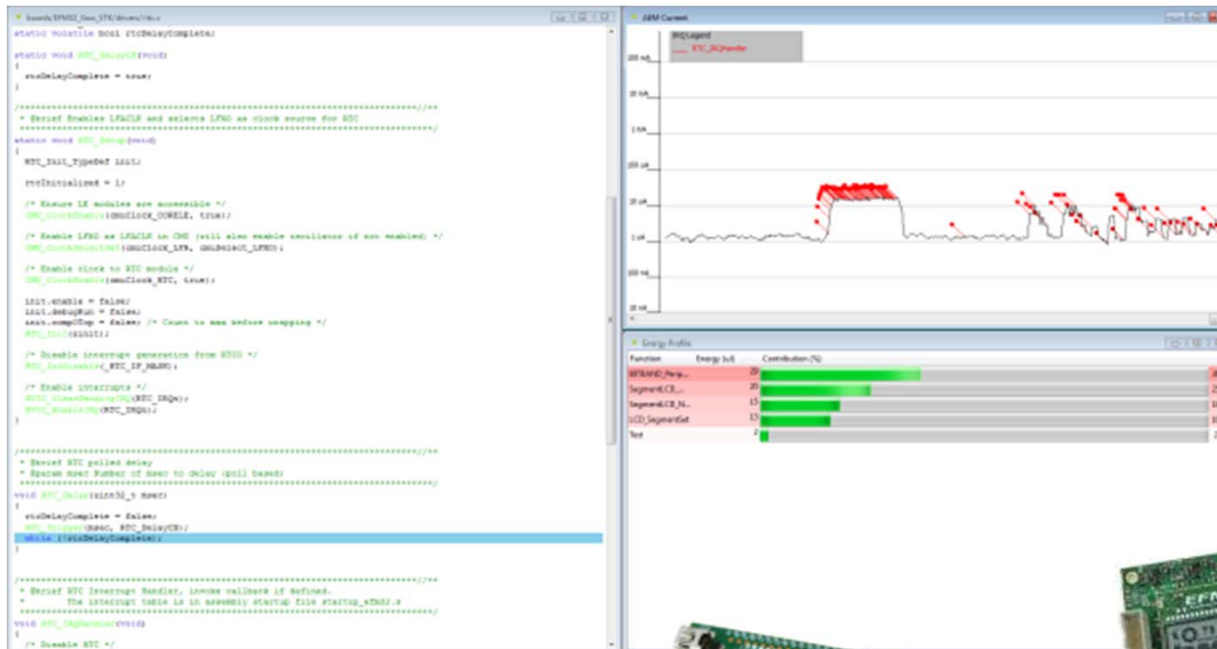
# Simplicity Studio

- Easily access all free software tools
- Always the latest updates and news

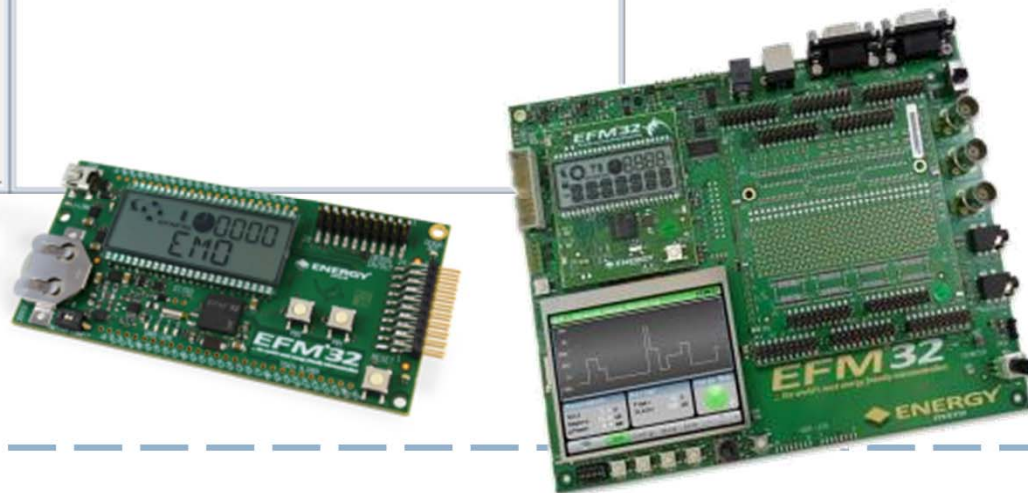


## AEM - Advanced Energy Monitoring and the energyAware Profiler

10



The energyAware Profiler is an energy debugging tool that use Advanced Energy Monitoring (AEM) data available from the development tools to perform real-time profiling and debugging of the associated object code.



## *Some interesting Appnotes*

- AN047 Interfacing Graphical Displays
  - FREE Segger emWin Graphics library
- AN048 Energy Optimized Display Application
  - uA Sharp Memory display application using emWin
- AN0052 USB MSD Host Bootloader
- AN0053 IR Sensor Monitoring Using LESENSE
  - Low Energy operation of Photointerrupter and Prox Sensor
- AN0054 Smart Phone Audio Jack Interface
  - EH application with audio jack communication
- AN0055 Speex Codec
  - On board Differential A/D and DAC

## *Some interesting Technologies*

- Wireless
  - 802.11 partnerships with Atheros, Digi, RTX
  - BTLE
    - Have our own BTLE Stack that can be used on our EFM32 with an external radio.
  - BT v2.1, BT Dual Mode
    - Searan dotstack
- E-Paper
  - PDI Eval Kits: 4.41" and Shelf Label Retronix Kit
  - Create boost converter with PRS System
- RTOS
  - Keil RTX RTOS allows RTC to be used in EM2
  - Pumpkin Salvo RTOS allows use of EM modes also
  - uCOS2/3, FreeRTOS, CMX, etc

## So you say you want a FREE Development Environment?



- Check out AN0023 ‘Configuring Eclipse & GNU/GCC Compiler, **[ask for detailed Installation Guide!!](#)**
  - Eclipse is a FREE Open Source Project Manager/IDE. Eclipse front-end is commonly used even in ‘Pay for’ IDE’s.

<http://www.eclipse.org/downloads/packages/eclipse-ide-cc-developers-includes-incubating-components/indigosr2>

- Codesourcery is the GNU toolchain containing a FREE gcc compiler/linker and gdb debugger.

<http://www.mentor.com/embedded-software/sourcery-tools/sourcery-codebench/editions/lite-edition/>

- Debugger: Your STK or DK is your FREE J-LINK Debugger!! This can be used with your own Target Board. Refer to the link below.

<http://forum.energymicro.com/topic/45-debugging-with-the-efm32-starterdevelopment-kits/page hl debug>



## *Software libraries*

- Provided free of charge with our chips
- Open source
- Production quality (but no warranty given)
- Supported by our technical support team
- CMSIS register definitions / HAL
- emlib driver library
- Protocol stacks (USB, RF, etc)
- GUI library

## USB stack

- Free stack with source available on web
- Includes:
  - Device – base, MSD, HID, CDC, VUD
  - Host – base, MSD, HID, HUB
- The Giant Gecko with USB stack has passed the USB-IF compliance certification
- Partner with commercial vendors (SEGGER emUSB and Jungo USBware)








## GUI library

- Free stack available – SEGGER emWin
- Includes:
  - emWin Color basic package
  - emWin GUIDRV Lin
  - Window manager
  - Memory device module
  - Anti-aliasing module
- Windows PC tools:
  - Bitmap converter
  - Font converter (supports also Asian languages)
  - Simulation environment
  - GUI-Builder



# Full featured hardware tools



	\$69 Gecko Starter Kit	\$69 Tiny Gecko Starter Kit	\$299 Gecko Development Kit	\$349 Leopard Gecko Development Kit	\$349 Giant Gecko Development Kit
					
<b>Device</b>	EFM32G890F128	EFM32TG840F32	EFM32G890F128 EFM32G290F128	EFM32LG990F256	EFM32GG990F1024
<b>Advanced Energy Monitoring</b>	Yes	Yes	Yes	Yes	Yes
<b>USB J-Link Debugger</b>	Yes	Yes	Yes	Yes	Yes
<b>Plug-in MCU and prototyping board</b>	-	-	Yes	Yes	Yes
<b>Onboard J-Trace</b>	-	-	-	Yes	Yes
<b>Screen</b> <i>7-Mar-13</i>	4x40 segment LCD	8x20 segment LCD	4x40 segment LCD (EFM32G890-DK only) 320x240 RGB TFT	320x240 RGB TFT w/touch	320x240 RGB TFT w/touch



[www.energymicro.com](http://www.energymicro.com)





# *EFR Update*



## ***EFR4D-STK6500***

- Available at launch, Q4 2013
- Familiar features: AEM and on-board J-Link debugger
- Modular approach – the same main board will support all frequency bands, with different RF modules
- 128x128 pixel SHARP Memory LCD
- Connects to any Gecko MCU STK, allowing two-chip configurations

## *Later kits*

- USB stick
- Wireless sensor nodes
- TBD



## *Protocol availability*

### **At Sample time:**

802.15.4-2006

BTLE – **Licensed WiCentric BTLE Stack!!**

SimpliPHY

### **Later:**

More to come...

## *Protocols details - SimpliPHY*

**SimpliPHY** is a very simple proprietary protocol with a very small footprint. Ideal for companies that want:

- Simple solution
- Make their own protocol
- Low complexity and foot print
- Full source code

Send, receive, set channel, energy detect, Clear channel Assessment.

## *Protocols details – Bluetooth Low Energy*

Stack will be provide by a partner – no license cost for customers.  
Stack is already certified and stable.

Profiles and services that will be supported at launch time (minimum list):

- Alert Notification Profile
- Blood Pressure Profile
- Find Me Profile
- Heart Rate Profile
- Phone Alert Status Profile
- Proximity Profile
- Time Profile
- Battery Service
- Blood Pressure Service
- Device Information Service
- Heart Rate Service
- Immediate Alert Service
- Link Loss Service
- TX Power Service
- Weight Scale
- Blood Glucose
- Proprietary Profiles

## *Protocols details – 802.15.4*

- Non Beacon Mode
- Beacon Mode
- Security (802.15.4-2006)
- 868/915 MHZ
- 2.4 GHZ

All features required for running ZigBee PRO, ZigBee RF4CE, ZigBee IP/6Lowpan protocols.

# Using EFM32 for wireless applications



EFM32 is an ideal host processor paired together with a wireless module or transceiver.

Example: Several companies now supply low Power WIFI modules that contain an EFM32 MCU. Example a module from RTX:





[www.energymicro.com](http://www.energymicro.com)





# *Additional EFM32 Slides*



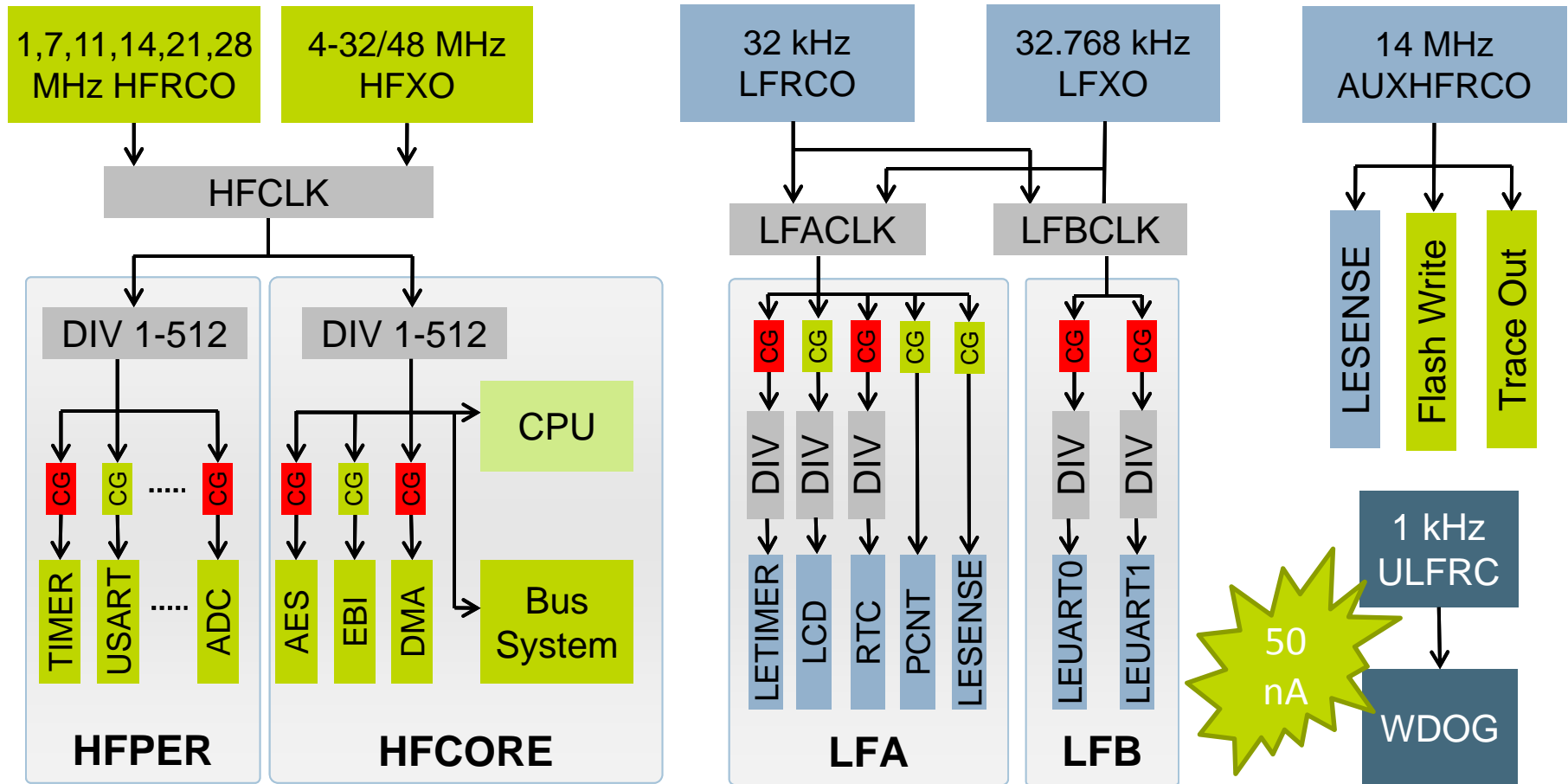


# *Core and Peripherals*





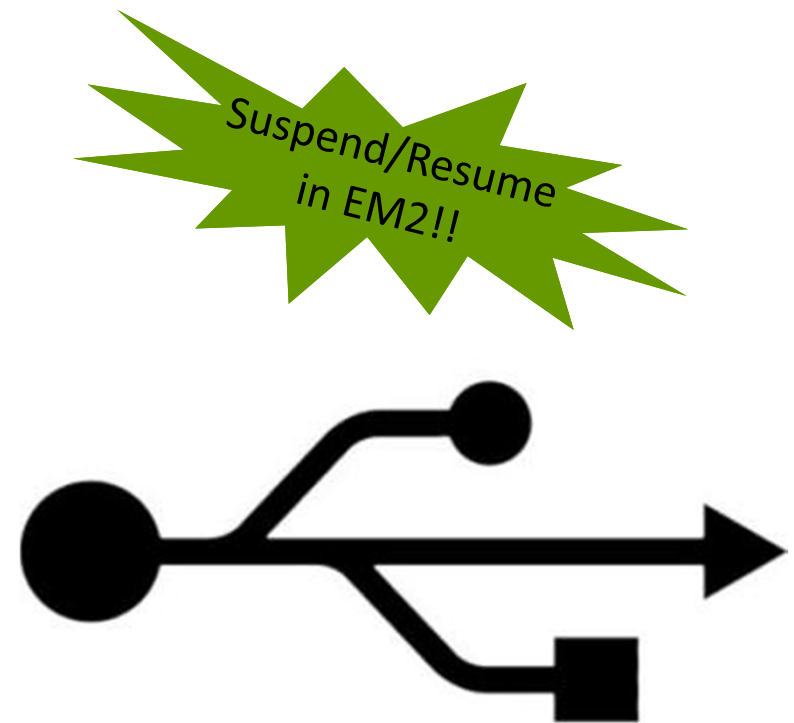
# Clocks and Oscillators



# Universal Serial Bus (USB)

## USB Highlights

- USB 2.0 compliant
- Support for USB Device, Host and On-The-Go (OTG)
- Full speed (12 Mbit/s)
- 14 endpoints (2 KB buffers)
- Integrated 3.3V regulator (up to 100 mA)
- Dedicated DMA for USB
- Pre-programmed USB device bootloader
- Free stack in Simplicity Studio
  - Mass Storage Host/Device
  - Human Interface Host/Device
  - Vendor Unique Device
  - Communication Class Device (USB-to-RS232)

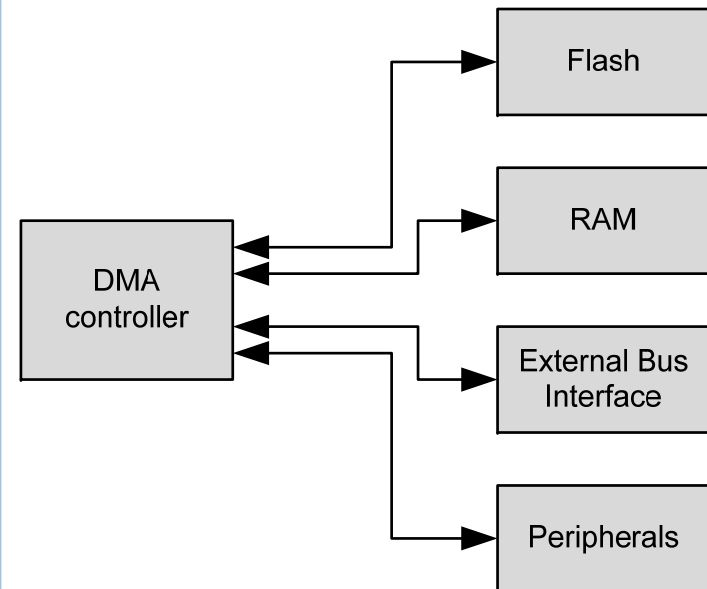


# Direct Memory Access Controller



## DMA Highlights

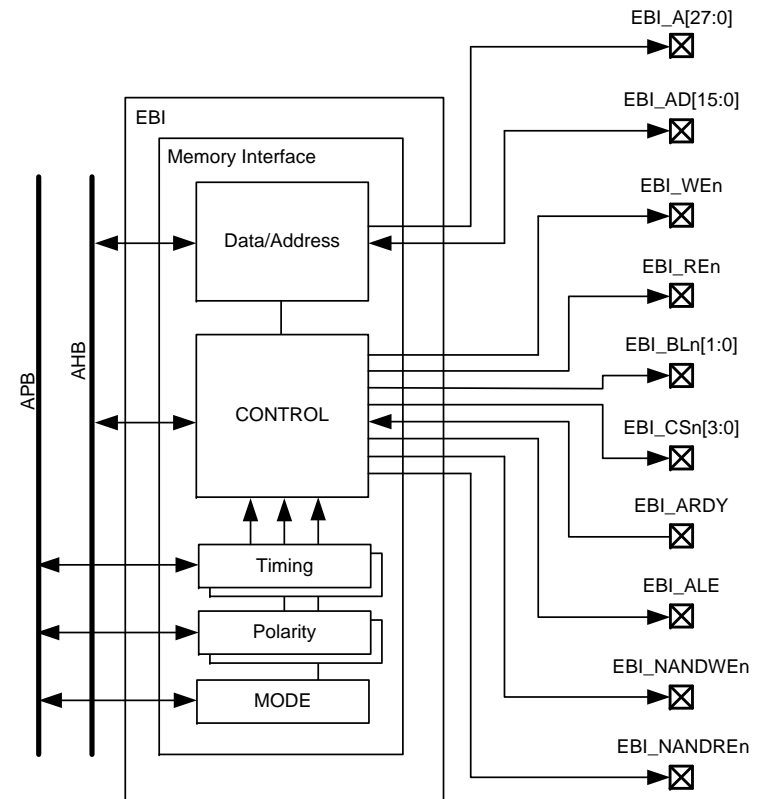
- Transfer between Flash/RAM and peripherals
- 8 channel DMA
  - 12 channels in LG/GG/WG
- Multiple operational modes
  - Scatter-Gather, Ping-pong
- Reduce workload of CPU
- Reduce latency
- **8.12uA/MHz**



# External Bus Interface

## EBI Highlights

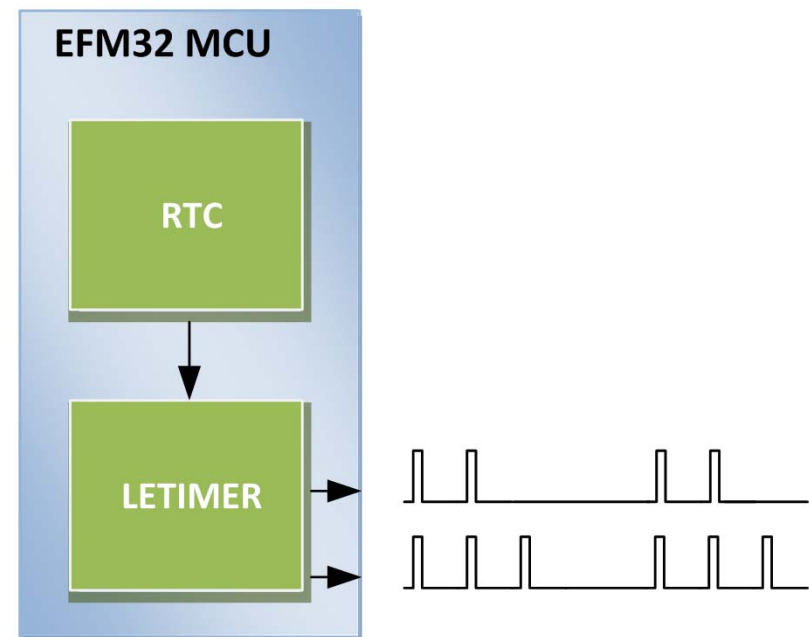
- **Standard EBI (Gecko)**
  - **External SRAM**
  - **Displays (8080 interface)**
  - **Memory mapped**
- **Giant/Leopard/Wonder Gecko EBI**
  - **Gecko EBI compatible**
  - **Independent timing for 4 CS**
  - **32-bit data access**
    - **Code execution**
  - **28 address lines and 16 data lines**
  - **NAND Flash support**



# Low Energy Timer

## Low Energy Timer Highlights

- 16-bit counter, 8-bit repeat
- Clocked from LFXO/LFRCO/ULFRCO
- Waveform generation
- Duty cycle control of external components/sensors
- Available down to Stop Mode (EM3)
- **150nA**



# Real Time Counter

## RTC Highlights(100nA)

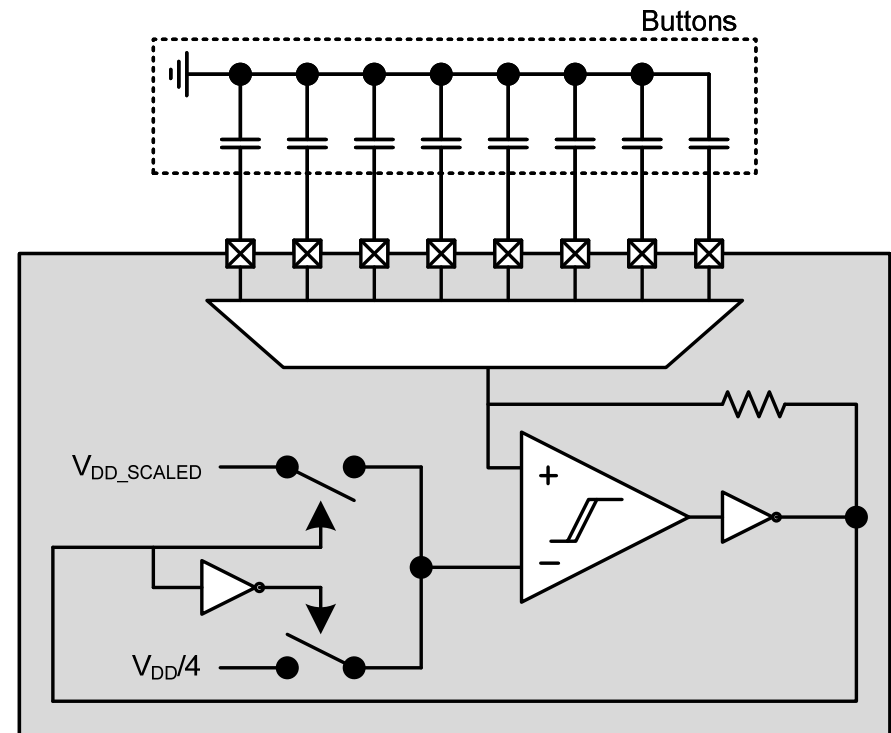
- Real Time Counter
  - 24-bit counter
  - 2 compare values
  - Clocked from LFXO/LFRCO/ULFRCO
  - Available in EM0 – EM3
- Backup Real Time Counter (LG/GG/WG)
  - 32-bit counter
  - Clocked from LFXO/LFRCO/ULFRCO
  - Wake-up on LFXO failure
  - Available in EM0 - EM4
  - Can run from backup power



# Analog Comparators

## ACMP Highlights

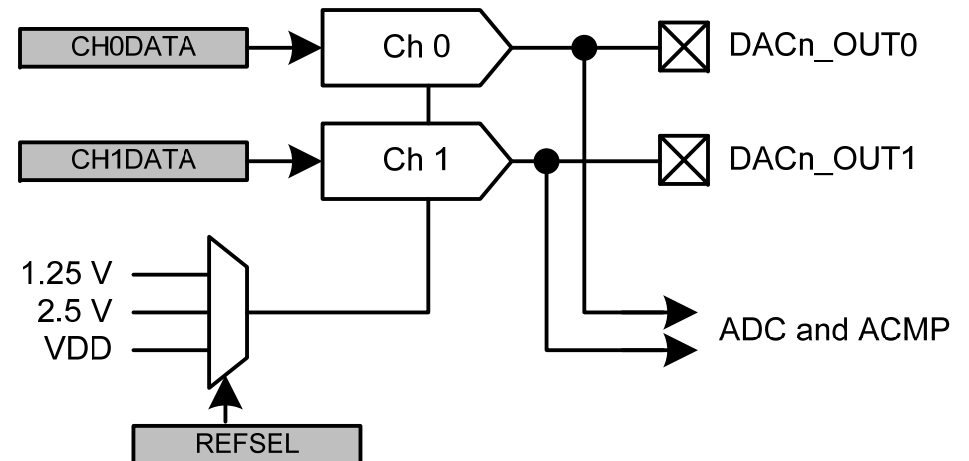
- Up to 2 analog comparators
- 8 input pins per comparator
- Programmable speed/current
  - 4.5  $\mu\text{s}$  / 0.1  $\mu\text{A}$
  - 0.2  $\mu\text{s}$  / 2  $\mu\text{A}$
- Capacitive Sense mode
- Internal references



# Digital to Analog Converter

## DAC Highlights

- 12-bit resolution
- 200  $\mu\text{A}$  @ 500 ksps
- 38  $\mu\text{A}$  @ 1 ksps
- 2 independent channels
- Continuous/sample&hold
- Internal references
- Sine generation mode
- PRS/DMA Trigger

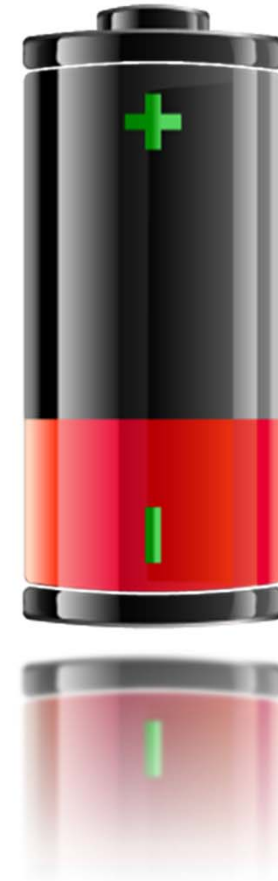




# Power Supply Supervision

## Power Supervision Highlights

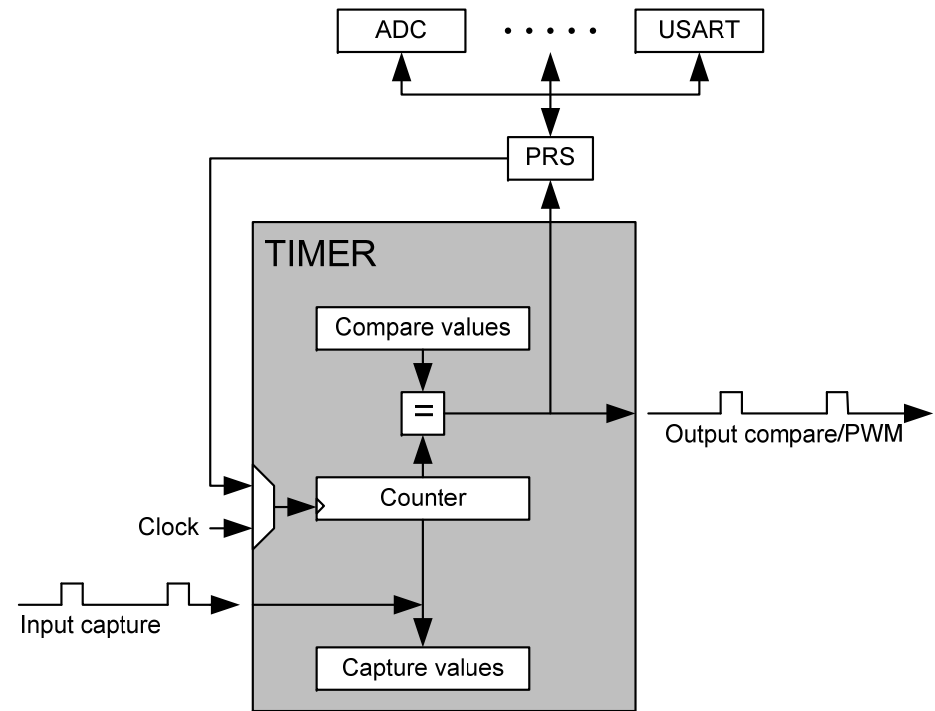
- 1.85 V to 3.8 V
- Power-on Reset
  - Always enabled
- Brown-out Detector
  - Enabled in EM0 – EM3
  - Available in EM4 on LG/GG/WG
- Voltage/Battery Supply Comparator
  - Programmable trigger level
  - Interrupt trigger
- **100nA**



# High Frequency Timer/Counters

## Timer/Counter Highlights

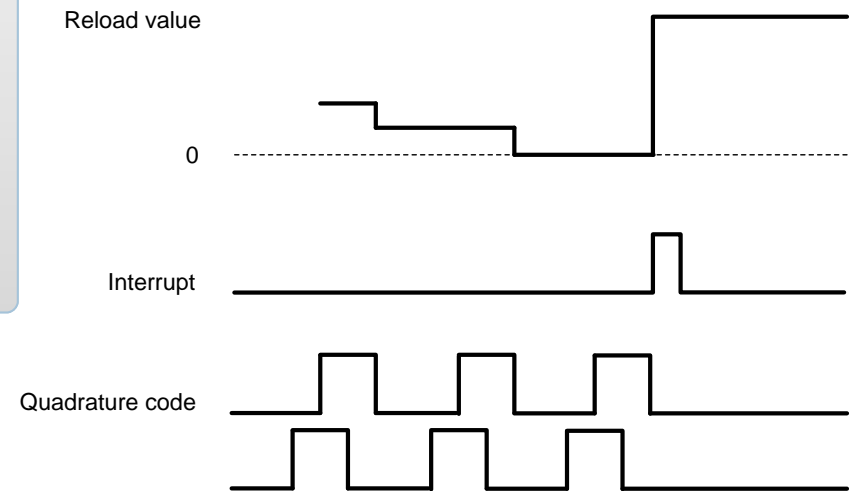
- Up to 3 16-bit Timers
  - Up, Down, Up/Down Modes
  - Quadrature Decoder
  - 3 Compare/Capture/PWM
  - Dead-Time Insertion on TIMER0
- SysTick Timer
  - Integrated in Cortex-M
  - OS Timer



# Pulse Counter

## Pulse Counter Highlights

- Up to 3 8/16-bit Pulse Counters included
- Counts incoming rising or falling edges
- Asynchronous quadrature decoder
  - Interrupt on direction change
- Available down to Stop Mode (EM3)

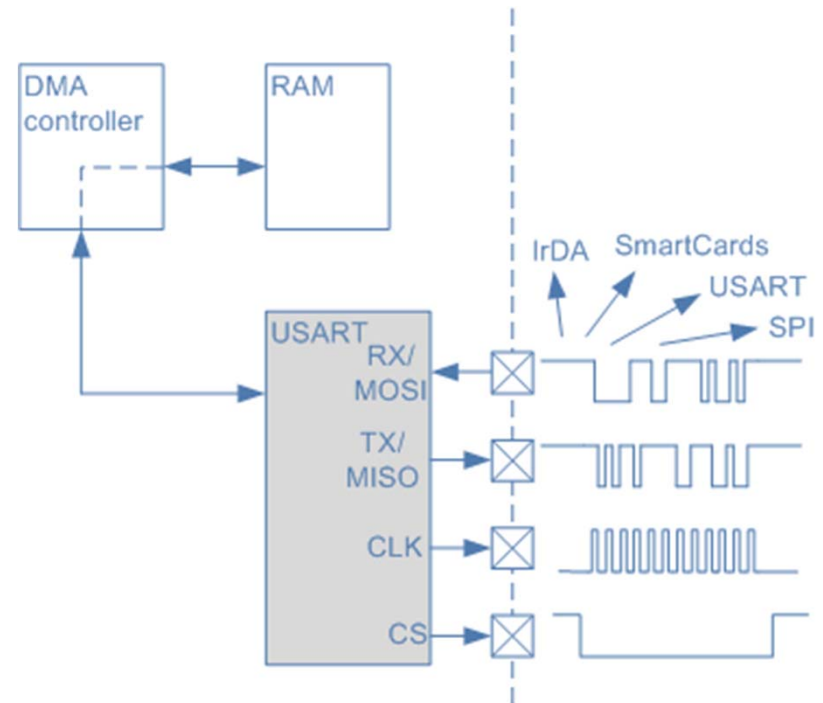


# SPI and UART



## SPI and UART Highlights

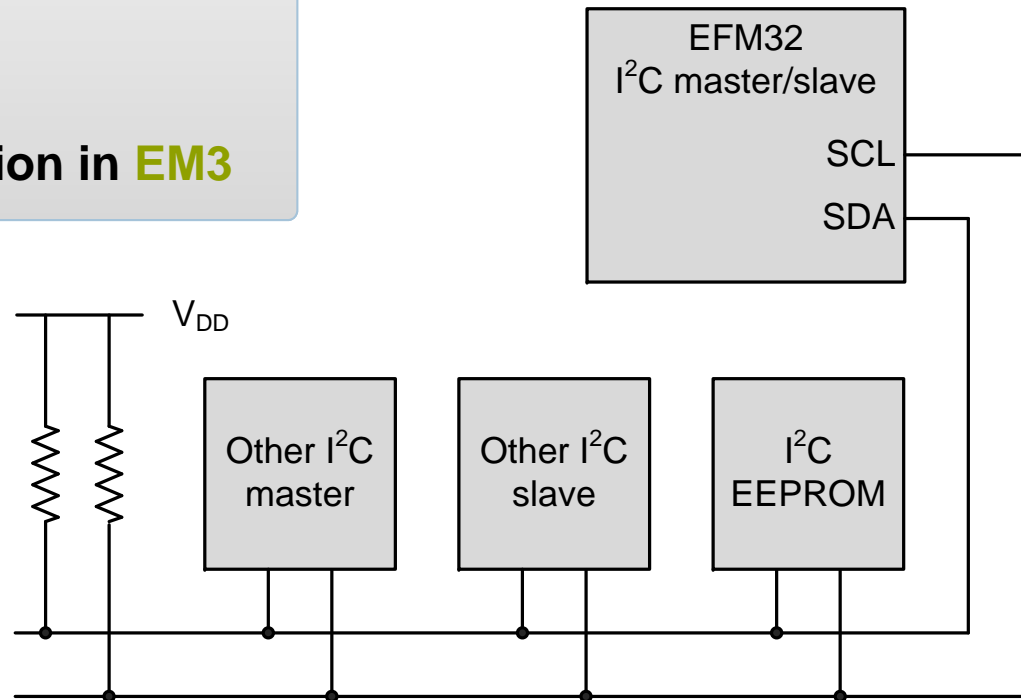
- Up to 3 USARTs
  - UART/SPI (master/slave)
  - IrDA
  - SmartCards (ISO7816)
  - 8 Mbit/s UART, 16 Mbit/s SPI master
  - I<sup>2</sup>S support (ZG, TG, LG, GG and WG)
- Up to 2 UARTs
  - Subset of USART with support for asynchronous communication



# I<sup>2</sup>C

## I<sup>2</sup>C Highlights

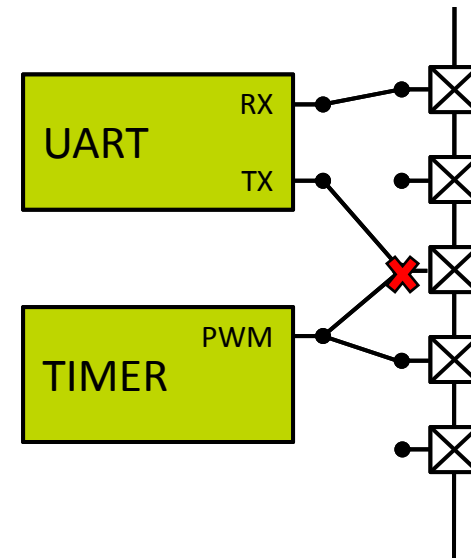
- Up to 2 I<sup>2</sup>C peripherals included
- I<sup>2</sup>C and SMBus support
- Data rates up to 1 MBit/s
- Hardware address recognition in **EM3**



# General Purpose Input/Output

## GPIO Highlights

- Up to 93 GPIO pins
- Configurable
  - Pull up / down
  - Input/Output enable
  - Drive strength (0.5 / 2 / 6 / 20 mA)
  - Input filter
- 16 pin interrupts
- Alternate functions
- Reset trigger from GPIO in EM4
  - ZG, TG, LG, GG and WG



# Debug/Programming

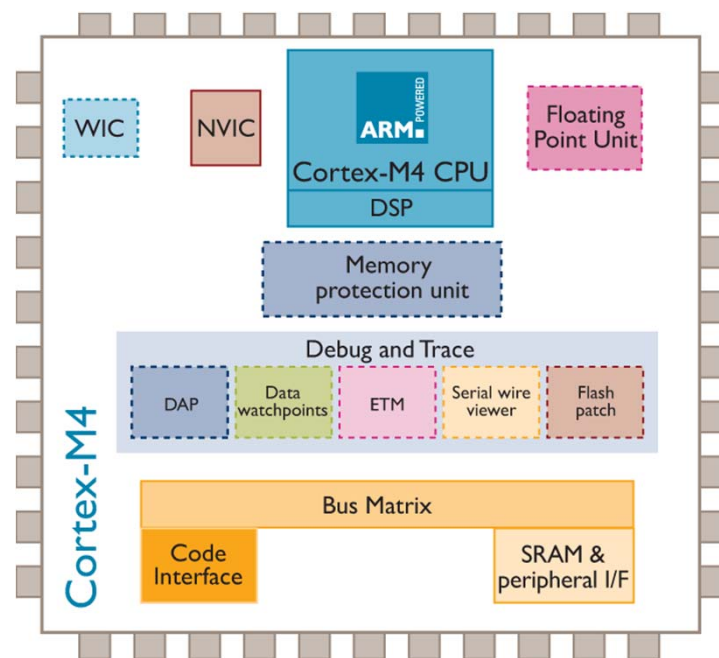
## Debug/Programming Highlights

- 2-wire Serial Wire debug interface
  - Debugging/Programming
- 1-wire Serial Wire Viewer output
  - **printf-style debug information**
  - PC sampling
- 5-wire Embedded Trace Macrocell (LG/GG/WG)
  - Instruction and Data Trace
- Debug lock for firmware protection
- Pre-programmed Bootloader
  - UART in all EFM32s
  - **UART+USB in parts with USB**

7-Mar-13



# ARM Cortex-M4F



## Cortex-M4F highlights

- High performance, low power platform
  - 1.25 DMIPS/MHz
  - 2.19 CoreMark/MHz
- Digital Signal Processing instructions
  - Single cycle 32-bit MAC
  - 8, 16-bit SIMD arithmetic
  - Single precision FPU
- Scalability for future products
- Software/tool compatible with Cortex-M
- Memory Protection Unit
- Embedded Trace Macrocell

