

德州仪器推出最新 **Stellaris® ARM® Cortex™-M4F** 微控制器 可提供领先的模拟集成、业界一流的低功耗及浮点性能



WW Stellaris Marketing Director

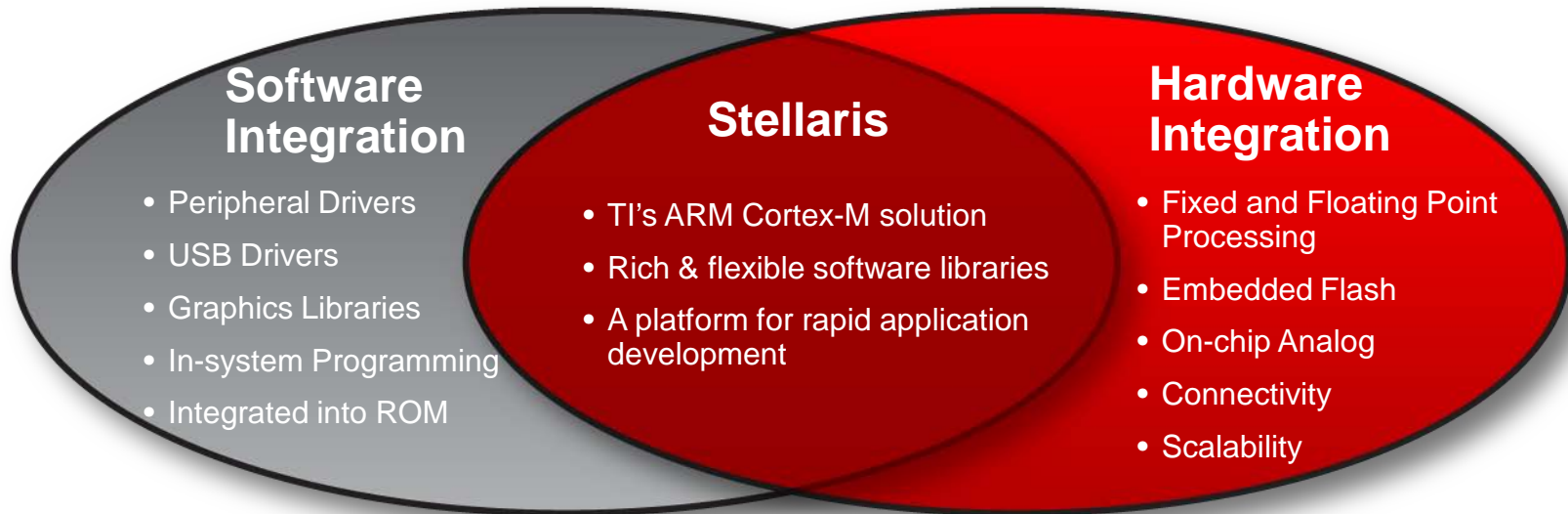
Miguel Morles

Stellaris® 微控制器产品线

全球市场总监

What is Stellaris®?

TI's 32-bit ARM® MCU family for HMI, Motion Control, Smart Grid, and Connectivity



- **Industry-leading software**

- StellarisWare libraries are free license & royalty free
- Libraries are skillfully architected, provided in ROM
- Develop in the environment of choice; compiled and proven on 5 separate IDEs

- **Advanced Integration**

- Up to 24 channels of 1MSPS 12-bit ADCs
- Only ARM MCU with an integrated ENET PHY
- CAN and USB Host / Device / On-The-Go support

- **Broad Portfolio**

- 180+ ARM Cortex-M3 & 40+ Cortex-M4 devices
- Up to 512KB Flash, 96KB SRAM
- 48-QFP up through 108-BGAs and 144-LQFP
- Price points starting at just \$1

- **Time to Market**

- Get started in 10 min or less
- Start development NOW using example applications
- Leverage open-tooled reference designs

Stellaris® MCUs – Versatile, Connected, Compact

Connectivity



Data Acquisition



Home Automation



Medical Connectivity



Serial-to-Ethernet
Bridge

Automation



Automated Motor Control



Home Automation

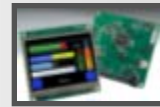
Human Machine Interface



Advanced
Remotes



Touch Interface



Graphics Displays



Security Monitoring



Biometric
Scanning



Networked
Access Control

Point of Sale



White goods



Electricity and
Flow metering

Exercise
Equipment












HVAC
Pump inverter
Compressor motor

Energy

LED signage



Stellaris[®] Product Portfolio

		Key Features	Applications	SW & Kits
Stellaris [®] ARM [®] Cortex [™] -M4F	 <p>LM4F210, 230</p> <p>Motion Control [+CAN, +USB]</p> <p>(\$2.55- \$4.85) [10KU pricing]</p>	<ul style="list-style-type: none"> Floating point perf. Best-in-class power Up to 12-bit ADCs Full-speed USB CAN Open support Motion control PWMs 	<ul style="list-style-type: none"> Industrial Automation Microprinters Motor control Low-end Digital Power Control 	 <p>EK-LM4F232</p>
	 <p>LM4F110, 120, 130</p> <p>Gen Purpose [+CAN, +USB]</p> <p>(\$2.15- \$4.75)</p>	<ul style="list-style-type: none"> Floating point perf. Best-in-class power Up to 12-bit ADCs Full-speed USB CAN Open support 	<ul style="list-style-type: none"> System Management Control Portable Medical Data logging Lighting control Scanners 	<p>For the full list visit www.ti.com/stellariskits</p>
Stellaris [®] ARM [®] Cortex [™] -M3	 <p>LM3S6000, 8000, 9000</p> <p>ENET [+CAN, +USB]</p> <p>(\$4.35- \$9.15)</p>	<ul style="list-style-type: none"> Integrated 10/100 ENET MAC & PHY Up to 12-bit ADCs Full-speed USB External Bus Interface 	<ul style="list-style-type: none"> HMI displays Industrial Automation Communication Gateways Point of Sale 	 <p>DK-LM3S9D96</p>
	 <p>LM3S3000, 5000</p> <p>USB [+CAN]</p> <p>(\$2.05- \$6.70)</p>	<ul style="list-style-type: none"> Full-speed USB Up to 12-bit ADCs I2S audio CAN Open support External Bus Interface 	<ul style="list-style-type: none"> Gaming accessories MFI-OS accessories HMI displays Motor control Scanners 	 <p>EK-LM3S3748</p>
	 <p>LM3S100, 1000, 2000</p> <p>Gen Purpose [+CAN]</p> <p>(\$1.90- \$5.50)</p>	<ul style="list-style-type: none"> Up to 12-bit ADCs External Bus Interface Small footprint CAN Open support Motion control PWMs 	<ul style="list-style-type: none"> Home appliances Industrial automation e-Metering Motor control LED signage 	 <p>EK-LM3S811</p>

Stellaris Evaluation Kits: “Zero-to-32bits” in 10 minutes

- **Everything a developer needs to get up and running in 10 minutes or less**
 - Each kit includes: evaluation board(s), all required cables, a choice of evaluation tools suites for popular development tools, documentation, StellarisWare® software, and applications notes



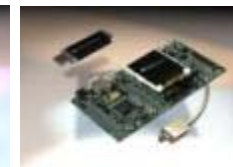
EK-LM3S811
Low pin count
49 USD



EK-LM3S1968
High pin count
59 USD



EK-LM3S2965
CAN Functionality
79 USD



EK-LM3S3748
USB Host/Device
109 USD



EK-LM3S6965
Ethernet MAC+PHY
69 USD



EK-LM3S8962
Ethernet+CAN
89 USD



EK-LM3S9D90
Ethernet+USB OTG
99 USD



EK-LM3S9D92
Ethernet+OTG+MC
99 USD



EK-LM4F232
USB + CAN
149 USD

- **Five versions of each kit:**



EKK-LM3Sx

- ARM RealView Microcontroller Development Kit tools with 32KB address Limit



EKI-LM3Sx

- IAR Embedded Workbench KickStart with 32KB address limit



EKC-LM3Sx

- Sourcery CodeBench G++ GNU with 30-day evaluation license



EKT-LM3Sx

- Code Red Technologies Red Suite with 90-day evaluation license



EKS-LM3Sx

- TI Code Composer Studio with full evaluation license locked to board

Stellaris[®] Roadmap (Public)

ARM Cortex-M3

LM3S9000
LM3S8000
LM3S6000



Fixed Point
ENET MAC & PHY
USB & CAN options

LM3S5000
LM3S3000



Fixed Point
USB H/D/OTG
CAN options

LM3S2000
LM3S1000
LM3S800



Fixed Point
General Purpose
CAN options

ARM Cortex-M4F Floating Point

LM4F13x
LM4F12x



RTP May 12 (TMX Now)

- USB H/D/OTG + CAN
- 80 MHz
- 256K Flash / 32K SRAM
- Low-power hibernate
- 2 x 1 Msps 12-bit ADCs
- 8x UART, up to 6x I2C, 4x SPI

LM4F23x



RTP May 12 (TMX Now)

- USB H/D/OTG + CAN
- Motion Control Peripherals
- 80 MHz
- 256K Flash / 32K SRAM
- Low-power hibernate
- 2 x 1 Msps 12-bit ADCs
- 2 x CAN
- 8x UART, up to 6x I2C, 4x SPI

LM4F11x



RTP May 12 (TMX Now)

- 80 MHz
- 256K Flash / 32K SRAM
- Low-power hibernate
- 2 x 1 Msps 12-bit ADCs
- 8x UART, up to 6x I2C, 4x SPI

LM4F21x



RTP May 12 (TMX Now)

- Motion Control Peripherals
- 80 MHz
- 256K Flash / 32K SRAM
- Low-power hibernate
- 2 x 1 Msps 12-bit ADCs
- 2 x CAN
- 8x UART, up to 6x I2C, 4x SPI

德州仪器最新 Stellaris® ARM® Cortex™-M4F 微控制器, 可提供领先的模拟集成、业界一流的低功耗及浮点性能

凭借浮点性能及领先的集成度, 降低系统成本并提升性能

无需为获得高精度而牺牲性能

- 用于实现高精度的高性能的12位ADC和模拟比较器
- 所有的 Stellaris Cortex-M4F MCU 都提供浮点运算单元
- 高达 256KB 闪存和 32KB 的 SRAM
- 丰富的连接外设: 8个UART, 6个I2C, 4个SPI, 2个CAN、1个USB OTG

提高便携性并满足功率预算

业界一流的
低功耗

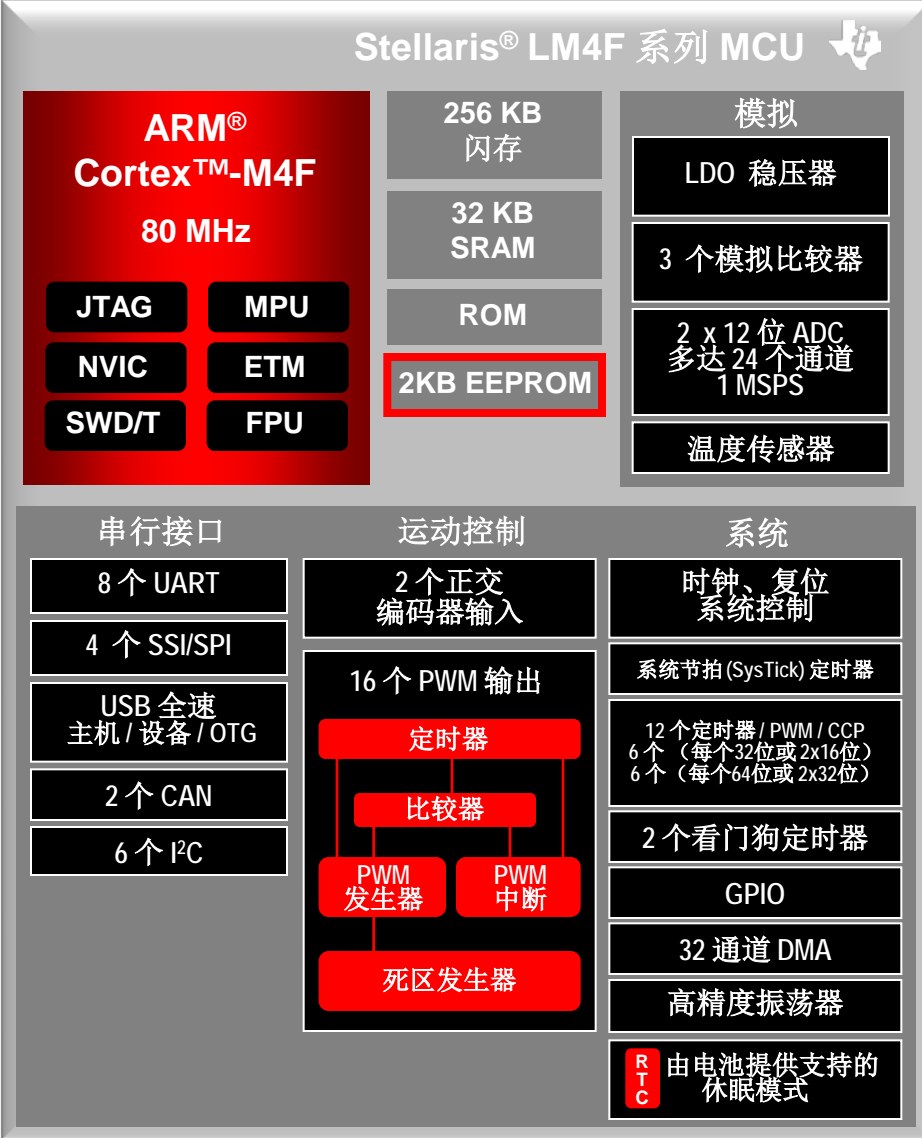
- 待机电流低至 1.6 μ A
- 运用先进的TI 模拟技术提升额外的系统效率

可借助 270+ 多款 Stellaris MCU 轻松实现设计调整, 并利用稳健的 StellarisWare 软件及工具加速产品的上市进程

- TI 独有的StellarisWare® 软件实现了轻松迁移至新型 Cortex-M4F 的能力, 旨在最大限度地提高代码复用率
- 预载软件库到片内独有的确ROM区, 预载软件库包括外设驱动程序库、启动加载程序及校验和
- 简单易用型评估套件可实现在 10 分钟或更短的时间里跨越式启动设计
- 基于 65 nm 工艺来实现更高速度、更大内存及超低功耗的发展路标图



40 多款 Stellaris Cortex™-M4F的MCU



高性能模拟集成

- 两个 1 MSPS 12 位 ADC
 - 无需硬件平均
- 三个模拟比较器

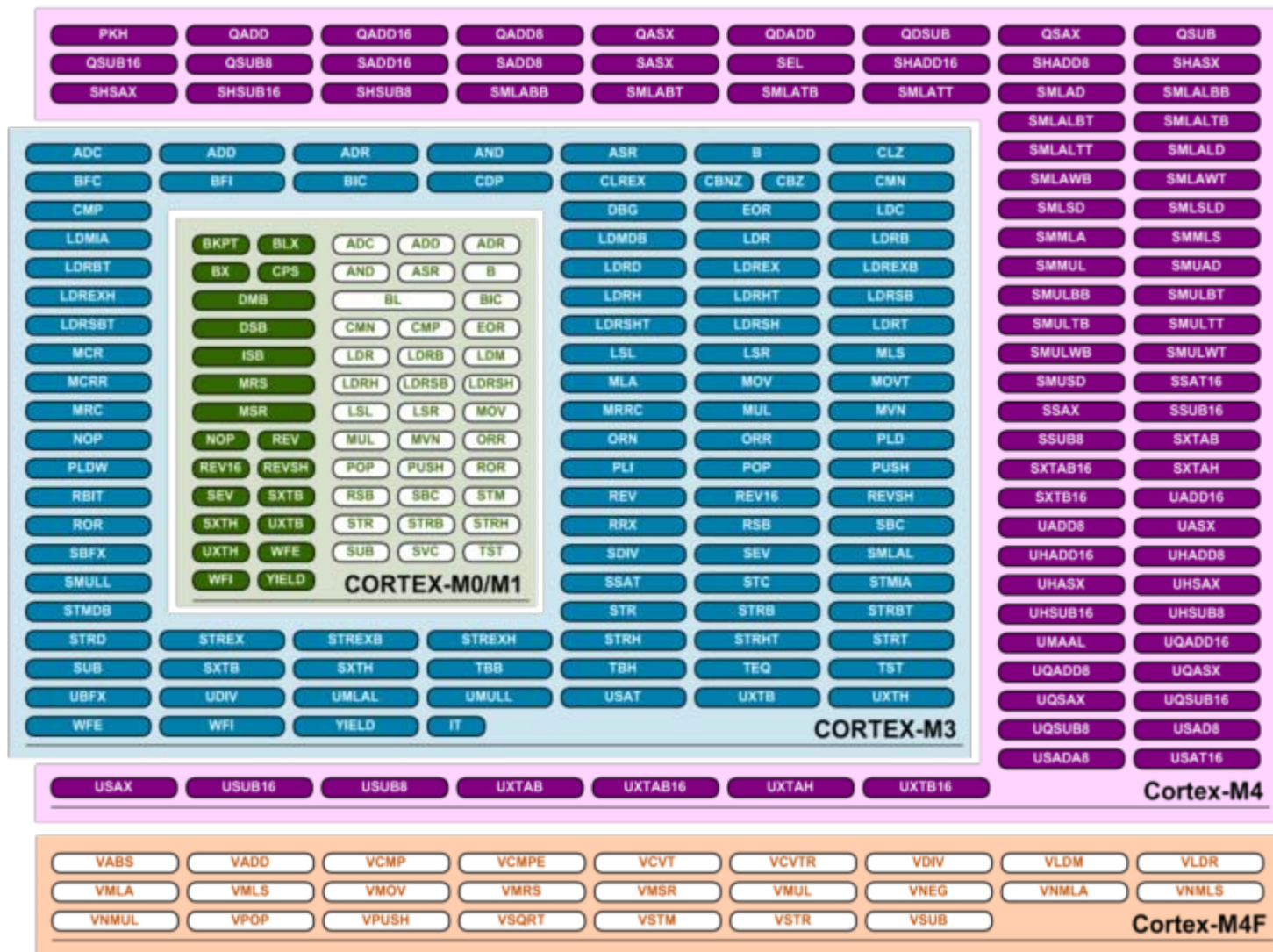
丰富的连接功能:

丰富的连接外设: 8个UART,6个I2C,4个SPI,2个CAN、1个USB OTG

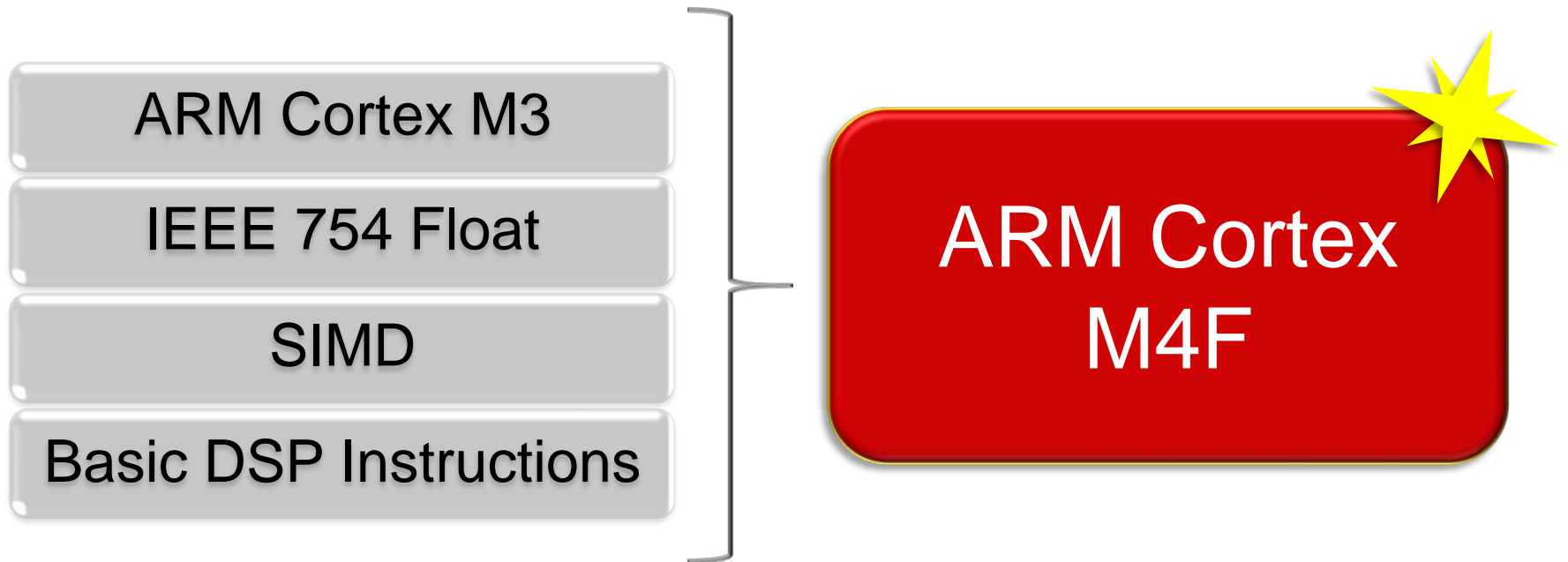
最低功耗的 Stellaris MCU

- 待机电流低至 1.6 μA
- 运行 RTC 模式低至 1.7 μA
- 唤醒时间: 500μs 或更短
- 基于 TI 专有的 65nm 工艺技术

Stellaris LM4Fx is ISA-compatible with LM3Sx



Cortex-M4F Benefits (wrt M3)



Cortex M4F Enhances Audio

Application	Cortex-M4F vs. Cortex-M3
Audio – window overlap & add	1.8-2.6x Faster
FIR Filter	2x Faster
IIR Filter	2x-3x Faster
MP3 Decode	2x Faster, 15% code reduction
WMA Decode	1.6x Faster, 9% code reduction
Audio Post Processing	2x Faster, 20% code reduction

Cortex M4F Enhances Motor Control

Application	Cortex M4F vs. Cortex M3
Motor Control – Clarke Transform	5x Faster
Motor Control – Park's Transform	7x Faster
PID	4x Faster

Cortex M4F Enhances DSP

Application	Cortex M4F vs Cortex M3
FFT	2x Faster
Matrix Multiplication	4x Faster
Correlation (Floating Point)	10x Faster

Single-Cycle MAC Benefit – IIR Filter Example

	<u>Cortex-M3</u>	<u>Cortex-M4</u>
	<u>cycle count</u>	<u>cycle count</u>
<code>xN = *x++;</code>	2	2
<code>yN = xN * b0;</code>	3-7	1
<code>yN += xNm1 * b1;</code>	3-7	1
<code>yN += xNm2 * b2;</code>	3-7	1
<code>yN -= yNm1 * a1;</code>	3-7	1
<code>yN -= yNm2 * a2;</code>	3-7	1
<code>*y++ = yN;</code>	2	2
<code>xNm2 = xNm1;</code>	1	1
<code>xNm1 = xN;</code>	1	1
<code>yNm2 = yNm1;</code>	1	1
<code>yNm1 = yN;</code>	1	1
Decrement loop counter	1	1
Branch	2	2

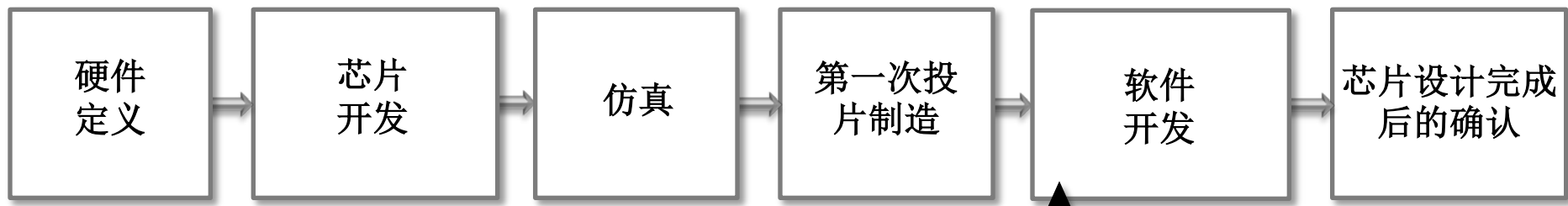
$$y[n] = b_0x[n] + b_1x[n-1] + b_2x[n-2] - a_1y[n-1] - a_2y[n-2]$$

- Only looking at the inner loop, making these assumptions
 - Function operates on a block of samples
 - Coefficients b_0 , b_1 , b_2 , a_1 , and a_2 are in registers
 - Previous states, $x[n-1]$, $x[n-2]$, $y[n-1]$, and $y[n-2]$ are in registers
- Inner loop on Cortex-M3 takes 27-47 cycles per sample
- Inner loop on Cortex-M4 takes 16 cycles per sample (**40 to 65% cycle reduction!!!**)

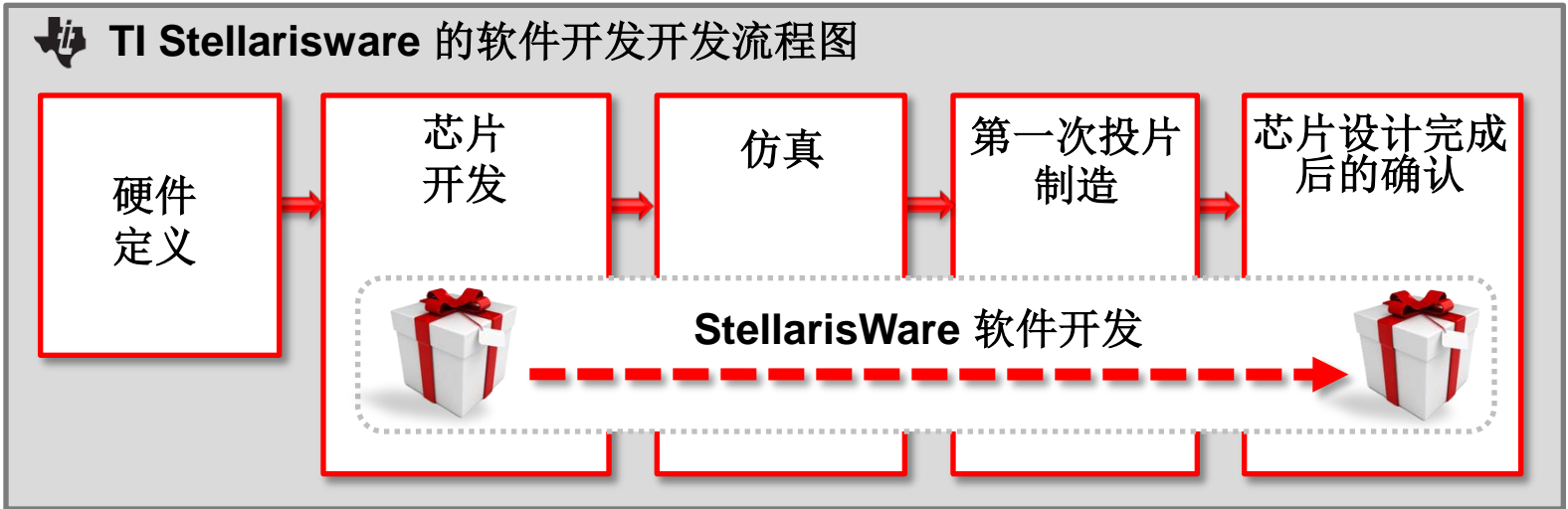
享有TI 独有的StellarisWare[®] 软件库的软件开发方法

一 软件开发并不是事后的补救

一般的软件开发流程图



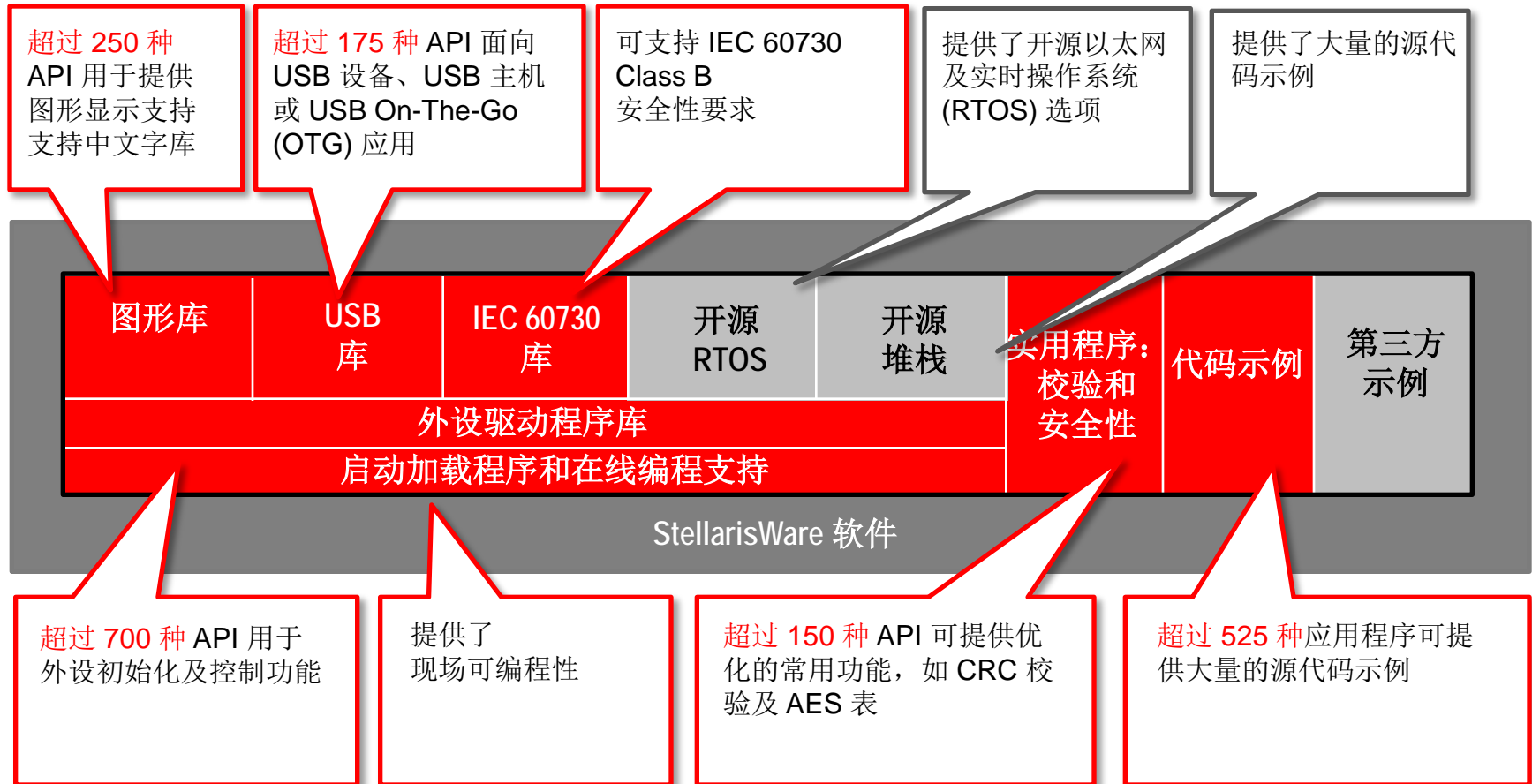
软件开发直到第一次投片制造才开始!



TI 独有的StellarisWare® 软件库



- 所有的程序设计均可采用 C/C++ 语言，甚至包括中断服务例程及启动代码
- 包含代码和免版税的程序库，用于提供应用支持



StellarisWare® USB Library

- **Free license & royalty-free** drivers plus example applications to accelerate USB implementation on Stellaris MCUs
- Examples available:
 - **Device Examples:**
 - HID Keyboard
 - HID Mouse
 - CDC Serial
 - Mass Storage
 - Generic Bulk
 - Audio
 - Device Firmware Upgrade
 - Oscilloscope
 - **Host Examples:**
 - Mass Storage
 - HID Keyboard
 - HID Mouse
 - Isochronous Audio Input
 - **OTG Examples:**
 - SRP (Session Request Protocol)
 - HNP (Host Negotiation Protocol)*
 - **Windows INF for supported classes**
 - Points to base Windows drivers
 - Sets config string
 - Sets PID/VID
 - Precompiled DLL saves development time
 - **Device framework integrated into USBLib**
- **USB Device Firmware Update (DFU) now available in ROM; just plug-in and reprogram your firmware!**
- TI sub-licenses Stellaris VID & PIDs for customer use



StellarisWare Graphics Library Examples



Primitives



Radio Buttons



Checkbox



Security Keypad



Canvas



Push Buttons



Container

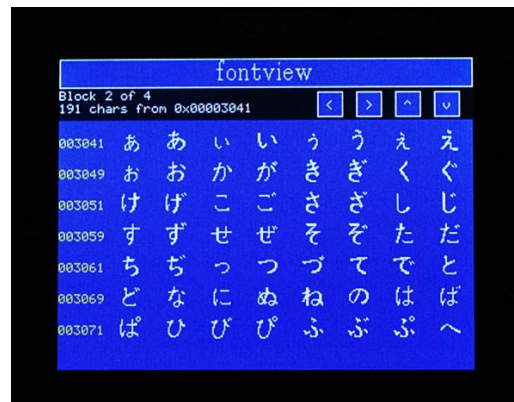
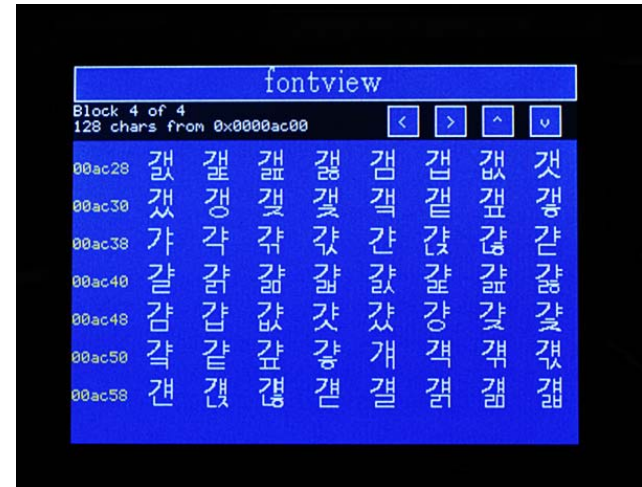


BLDC Touchscreen Motor Controller

StellarisWare® Graphics Library

Special Utilities

- *frasterize*: render your own font
 - *mkstringtable*: build multi-language string tables
 - *makefsfile*: dump binary files as C arrays
 - *Imi-button*: predefined button with shadow and 3-D
 - *pnmtoc*: Convert image file to GraphicsLib format
- **International Fonts**; program HMI in more languages
 - e.g. Chinese, Korean, Japanese ideographs, accented western European characters, etc.
 - Supports UTF8, ISO8859 and Unicode.



Low power on Stellaris LM4F

- **Lowest-power Stellaris MCUs**

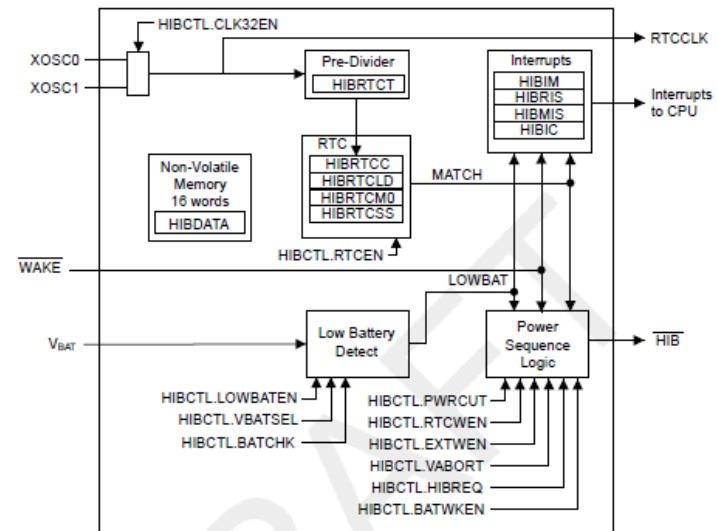
- Built on TI-proprietary 65nm technology
- Wakeup times of 500 us or less
- Active currents as low as 375 uA/MHz
- Standby modes as low as 1.6 μ A

- **Intelligent Design**

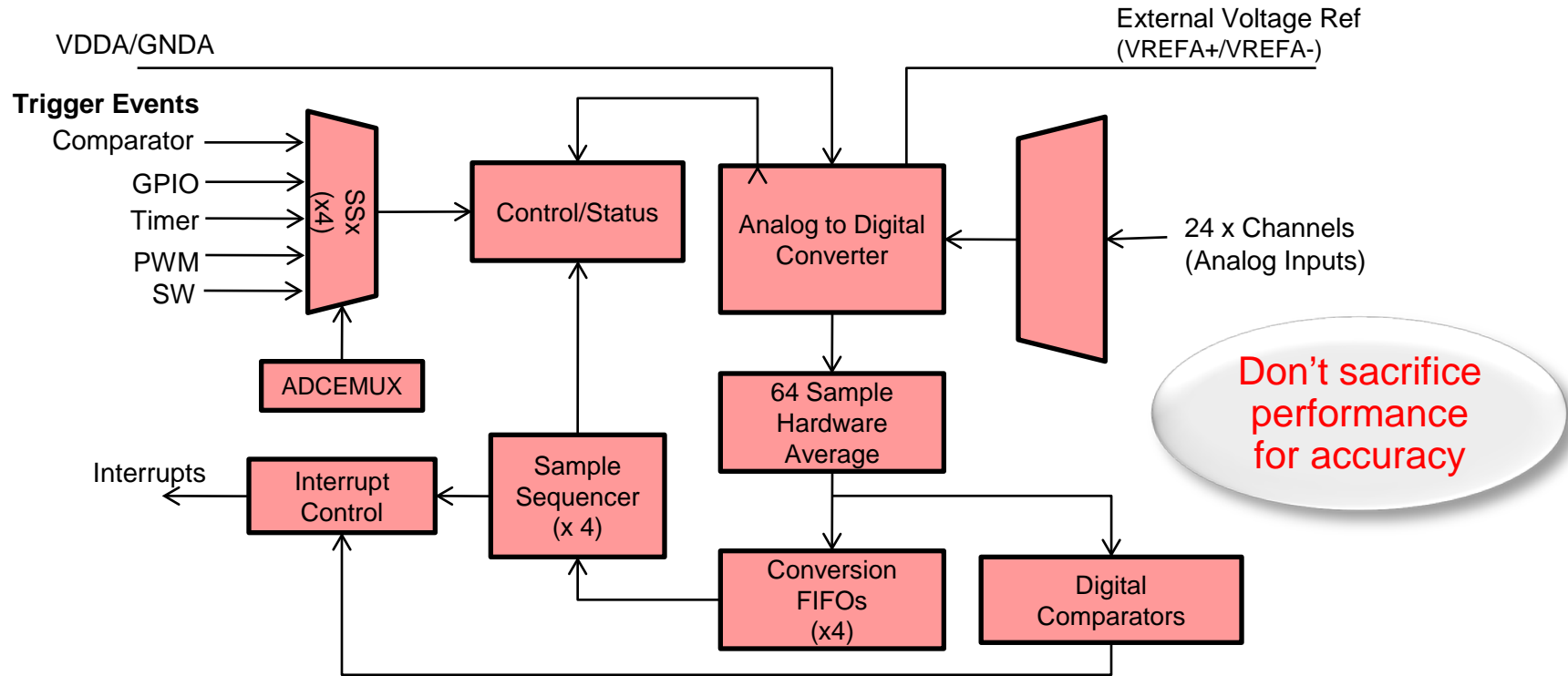
- Dedicated wake pin
- Retain your application state using 64 bytes of backup battery RAM
- Maintain your system state by retaining the state of the GPIO pins

- **Easy to use**

- Pick your wake events: RTC match, external wake, or low-battery detect
- Best-practice reference design available on evaluation kit



Analog Integration on Stellaris LM4F



Integration that saves customers \$

- 12-bit ADC @ 1 MSPS
- Built-in temperature sensor ($\pm 5^\circ \text{C}$)
- Eight built-in digital comparators
- Supports single-ended & differential inputs
- Three built-in analog comparators (not shown)

Intelligent ADC design for lower power

- Programmable sample sequencers (SSx)
- Conversion FIFOs to store conversions
- Internal triggering from other peripherals
- Automatic DMA transfers on completion

Integrated EEPROM on Stellaris LM4F

- **Integration that saves customers \$**
 - 2KB of integrated EEPROM
 - Customer BOM savings up to \$0.30 cents
- **Intelligent Design**
 - Avoid SW polling by utilizing an interrupt indicating write completion
- **Secure and Reliable**
 - Up to 96-bit password protection for stored information
 - Built in wear-leveling allows up to 500K erasures of a single word



10 分钟之内即可启动开发工作



简单易用型评估套件

- 所有的硬件及软件开发均可在 10 分钟或更短时间内启动
- 完整的外设功能
- 96 x 64 色 OLED 显示器凸显了 StellarisWare™ 免费许可图形库的优势
- 工程示例

在您中意的环境中进行设计：

- 得到了 5 种常用 IDE 的支持



Code Composer Studio™ IDE

Thank You !