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

业界首例 65 nm Cortex-M 微控制器现已面市，从而可提供更低功耗及更高性能水平，为整个 Stellaris 系列产品的发展计划打下了坚实基础

Loyal Bao 鲍震
德州仪器单片机产品线
Stellaris® 微控制器产品线
中国区业务拓展经理
The Embedded Industry’s Standard Architecture

- Chart reports and forecasts ‘unit’ growth
- Demonstrates ARM overall growth in consumer, industrial, automotive, and networking.
- ARM is the market share leader for licensable Core IP
- Why?
  - Result of ARM’s R&D spend of nearly 500% more than the closest licensable competitor over the past 4 years.

Worldwide Unit Production and Forecast

Source: Semico 1Q07

The ARM Ecosystem—the companies that provide:
- Development tools
- Training and support
- Design tools
- Operating systems
- Systems support
- Silicon
Do You Know?

• Semicast forecasted the 2010 ARM-based market at…
  20 Billion USD

• Semicast reported that 2010 results show that TI’s ranking is…
  TI is the leading supplier of ARM-based MCUs/MPUs

• The number of ARM cores shipped to date is ….
  25 Billion units

• TI’s total shipped ARM cores exceeds ….
  6 Billion units

• 70% of engineers consider the #1 processor selection criteria to be…
  Software as their #1 processor selection criteria
TI tailors its ARM® portfolio to address market demands

**Microcontrollers**

- **32-bit ARM® MCUs**
  - Stellaris®
    - ARM®
    - Cortex™-M3 & Cortex™-M4F
    - Up to 80 MHz
    - Flash 64 KB to 256 KB
    - USB, ENET, MAC+PHY, CAN, ADC, PWM, SPI
    - Motion control, HMI, industrial automation
    - $1.00 to $8.00
  
- **32-bit ARM® safety MCUs**
  - Hercules™
    - ARM®
    - Cortex™-R4F
    - Fixed/floating up to 220 MHz
    - Flash 256 KB to 3 MB
    - USB, ENET, FlexRay, Timer/PWM, ADC, CAN, LIN, SPI, I²C, EMIF
    - Safety, transportation, industrial & medical
    - $5.00 to $30.00

**Microprocessors**

- **32-bit ARM® MPUs**
  - Sitara™
    - ARM®
    - Cortex™-A8 ARM9™
    - Value Line to 600 MHz
    - Perf. Line to 1.5 GHz
    - Up to 32 KB I/D cache
    - 256 KB L2, LPDDR, DDR2/3 support
    - GEMAC, PCIe+PHY, SATA+PHY, CAN, USB+PHY, PRU
    - Industrial automation, portable data terminals, single-board computing
    - $5.00 to $50.00

- **DSP**
  - DSP+ARM® MPUs
  - C6000™
    - C6-Integra™
    - DaVinci™
    - 300 MHz to 1.5 GHz floating DSP + video accelerators
    - L2 Cache, mDDR, DDR2/DDR3
    - USB 2.0 OTG, GEMAC, SATA, SPI, UPP, PRU, PCIe2.0, McBSP, McASP
    - Video, audio, voice, vision, security, conferencing, test & measurement
    - $5.00 to $200.00
TI ARM® investment and innovation

1st single-chip digital baseband - DSP/ARM multi-core

- TI Licenses first ARM core
- *TI first licensee for ARM Cortex™- A8

- 1st multi-core applications processor, ARM9-based
- OMAP™ OMAP1510

- 1st ARM Cortex-A8 based silicon
- OMAP™ OMAP3

- DaVinci™ processors for digital video – ARM9-based SoCs
- DaVinci™

- Two ARM Cortex-R4 cores for automotive
- TMS570 MCU

- Stellaris® Fury Class
- Stellaris® DustDevil Class

- TI Licenses Cortex-A9

- TI Acquires Luminary Micro

- Stellaris® Tempest Class

- 1st R4F-based floating-point, dual-core auto MCU
- TMS570F MCU

- Stellaris® Firestorm Class

- TI launches Stellaris ARM Cortex-M4F and Hercules™ Safety MCUs

- TI Information – Selective Disclosure

TI has shipped over 6 billion ARM-based products and continues to invest in a large portfolio of scalable platforms from $1 to >1GHz

Stellaris® Roadmap

Note: All devices include mix of timers, UART, I2C, SPI, USB, I2S, EPI, Ethernet, CAN, PWM, ADCs, DMA. Complete peripheral set not shown for each device.
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

- 用于实现高精确度的高性能的 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

- 待机电流低至 1.6 μA
- 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 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
40 多款 超低价格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)

- ARM Cortex M3
- IEEE 754 Float
- SIMD
- Basic DSP Instructions

ARM Cortex M4F
### Cortex M4F Enhances Audio

<table>
<thead>
<tr>
<th>Application</th>
<th>Cortex-M4F vs. Cortex-M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio – window overlap &amp; add</td>
<td>1.8-2.6x Faster</td>
</tr>
<tr>
<td>FIR Filter</td>
<td>2x Faster</td>
</tr>
<tr>
<td>IIR Filter</td>
<td>2x-3x Faster</td>
</tr>
<tr>
<td>MP3 Decode</td>
<td>2x Faster, 15% code reduction</td>
</tr>
<tr>
<td>WMA Decode</td>
<td>1.6x Faster, 9% code reduction</td>
</tr>
<tr>
<td>Audio Post Processing</td>
<td>2x Faster, 20% code reduction</td>
</tr>
</tbody>
</table>

### Cortex M4F Enhances Motor Control

<table>
<thead>
<tr>
<th>Application</th>
<th>Cortex M4F vs Cortex M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Control – Clarke Transform</td>
<td>5x Faster</td>
</tr>
<tr>
<td>Motor Control – Park’s Transform</td>
<td>7x Faster</td>
</tr>
<tr>
<td>PID</td>
<td>4x Faster</td>
</tr>
</tbody>
</table>

### Cortex M4F Enhances DSP

<table>
<thead>
<tr>
<th>Application</th>
<th>Cortex M4F vs Cortex M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFT</td>
<td>2x Faster</td>
</tr>
<tr>
<td>Matrix Multiplication</td>
<td>4x Faster</td>
</tr>
<tr>
<td>Correlation (Floating Point)</td>
<td>10x Faster</td>
</tr>
</tbody>
</table>
Single-Cycle MAC Benefit – IIR Filter Example

- 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!!!)

<table>
<thead>
<tr>
<th></th>
<th>Cortex-M3 cycle count</th>
<th>Cortex-M4 cycle count</th>
</tr>
</thead>
<tbody>
<tr>
<td>$xN = *x++;$</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>$yN = xN * b0;$</td>
<td>3-7</td>
<td>1</td>
</tr>
<tr>
<td>$yN += xNm1 * b1;$</td>
<td>3-7</td>
<td>1</td>
</tr>
<tr>
<td>$yN += xNm2 * b2;$</td>
<td>3-7</td>
<td>1</td>
</tr>
<tr>
<td>$yN -= yNm1 * a1;$</td>
<td>3-7</td>
<td>1</td>
</tr>
<tr>
<td>$yN -= yNm2 * a2;$</td>
<td>3-7</td>
<td>1</td>
</tr>
<tr>
<td>$*y++ = yN;$</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>$xNm2 = xNm1;$</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>$xNm1 = xN;$</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>$yNm2 = yNm1;$</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>$yNm1 = yN;$</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Decrement loop counter</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Branch</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
享有 **TI 独有的 StellarisWare®** 软件库的软件开发方法

一一 软件开发并不是事后的补救

一般的软件开发流程图

![软件开发流程图](image)

**TI Stellarisware 的软件开发开发流程图**

![StellarisWare 软件开发](image)
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

超过 250 种 API 用于提供图形显示支持
超过 175 种 API 面向 USB 设备、USB 主机或 USB On-The-Go (OTG) 应用
可支持 IEC 60730 Class B 安全性要求
提供了开源以太网及实时操作系统 (RTOS) 选项
提供了大量的源代码示例

超过 700 种 API 用于外设初始化及控制功能
提供了现场可编程性
超过了 150 种 API 可提供优化的常用功能，如 CRC 校验及 AES 表
超过 525 种应用程序可提供大量的源代码示例
**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

- *ftrasterize*: render your own font
- *mkstringtable*: build multi-language string tables
- *makefsfile*: dump binary files as C arrays
- *lmi-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.
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
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

- 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
Blizzard Applications
Stellaris® MCUs – Versatile, Connected, Compact

Connectivity
- Data Acquisition
- Serial-to-Ethernet Bridge
- Point of Sale
- Graphics Displays
- Exercise Equipment
- Electricity and Flow metering
- HVAC Pump, inverter, Compressor motor

Human Machine Interface
- Advanced Remotes
- Touch Interface
- Medical Connectivity
- Networked Access Control

Automation
- Home Automation
- Automated Motor Control
- Security Monitoring
- Biometric Scanning

Energy
- White goods
- Networked Access Control

Security

LED signage

TI Information – Selective Disclosure

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Complete, modular wireless solutions

**Stellaris®**
2.4 GHz CC2560
*Bluetooth® Kit*

**Stellaris**
13.56MHz RFID
Wireless Kit

**Stellaris**
2.4 GHz SimpliciTI™
Wireless Kit

**Stellaris**
ZigBee®
Networking Kit
Stellaris® Bluetooth® Networking Kit

DK-EM2-2560B

Key features

- Proven protocol software, example applications, and StellarisWare® support for Bluetooth v2.1+EDR
- Advanced Audio Distribution Profile (A2DP) with Example Application
  - Connect and stream audio from your Android™, BlackBerry®, or iPhone®
- Serial Port Profile (SPP) Wire Replacement Example Application
  - Transmits accelerometer position data enabling drawing on DK-LM3S9B96 LCD screen
- Pairs with best-in-class performance Bluetooth transceiver
  - CC2560-PAN1325 module by Panasonic

Applications

- Cell phone accessories
- Mobile device accessories (iPod®, iPad®, etc.)
- Medical data aggregator
- Short-range serial communication replacement

$199 USD
Blizzard Opportunities in China

• Existing Opportunities
  – AC Induction motor control
    • Fast, accurate ADC; ARM Cortex-M core; Support
  – Permanent magnet motor control (for refrigerator compressor)
  – Industrial circuit breakers
  – Lighting control
    • Wired/wireless Communication Support, # of timers
  – Uninterruptible Power Systems
    • Fast, accurate ADC
  – Human machine interface
    • Graphics Library, Time to market
  – Fitness watches
    • Low Power Performance, Bluetooth enablement
  – RF networking
  – System Management Control applications
  Etc...

• Can you think of others?
  – Tell us!
Thank You !