NXP（恩智浦） MCU产品线

战略及新产品介绍

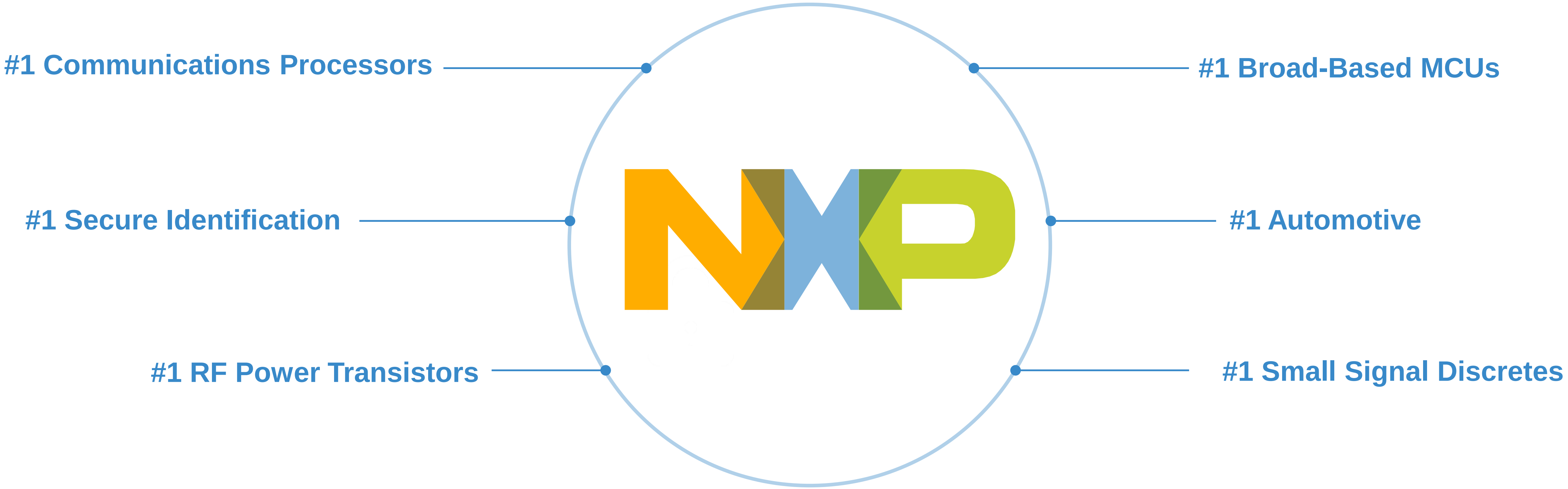
APF-DES-T2229

JULY 2016

PUBLIC

SECURE CONNECTIONS
FOR A SMARTER WORLD

A NEW POSITION OF STRENGTH



#1 Communications Processors

#1 Broad-Based MCUs

#1 Secure Identification

#1 Automotive

#1 RF Power Transistors

#1 Small Signal Discretes

~45,000 Employees

11,000+ Engineers

35+ Countries

9,000+ Patents

FOCUSING NXP SOLUTIONS ON HIGH GROWTH MARKETS

Secure, **Connected Vehicle**

- ADAS: Radar, V2X, Vision, Fusion, network processor
- Car entertainment
- In-vehicle networking
- Secure car access
- Secure car

End-to-end **Security & Privacy**

- Mobile transactions
- E-Government
- Smart bank cards
- User authentication
- Embedded security
- Cloud & Infrastructure Security

Smart, **Connected Solutions**

Consumer

- Mobile audio
- High-speed Interfaces
- Smartphone RF
- Personal health & fitness
- Healthcare

Industrial

- Smart home & buildings
- Smart cities, smart grid
- M2M, Industry 4.0
- Intelligent logistics
- 4.5G/5G Networks

日程

- NXP’s MCU产品线战略及路标
- Kinetis 5V新产品介绍：KE1X
- Kinetis安全类新产品介绍：K8X及KL8X

恩智浦MCU产品线

为何客户选择我们

- 加入了各种软件及硬件等生态环境工具的支持
- 在客户支持、质量及长生命周期供货等方面始终处于业界领先地位
- 与众多的合作伙伴共建生态系统
- 为大众市场提供完善的应用案例，方便中小用户的上手及应用裁剪

Example Customers

BOSCH Invented for life
AVNET
ARROW
Digi-Key
Electrolux
ABB
EMERSON Network Power
FLEXTRONICS
GREE
Haier
GARMIN
Continental
Honeywell
Insulet Corporation
Microsoft
MOUSER ELECTRONICS
SONOS
SONY
LAB126
Schneider Electric
SIEMENS
Whirlpool

Products

Kinetis & LPC 32-bit ARM® Microcontrollers	i.MX ARM® Applications Processors

Applications

Wearable / Healthcare
- Health / Fitness & Wireless Healthcare
- Diabetes & Cardiac Care
- Diagnostics & therapy

Smart Home
- Smart meters & grid
- Integrated wireless connectivity solutions
- Home energy control

Smart Accessories
- Game controllers and consoles
- Wearable computing
- eReaders, tablets, portable navigation

Vehicle Networking & Information
- Infotainment, software define radio
- Navigation systems, E-call

Home Appliances
- Energy efficient refrigerators, dishwashers
- Human-machine interface
- Connected appliances

Factory Automation & Drives
- Machine-to-machine
- Motor control
- Industrial networking

NXP

MCU-专业源于专注

ARM技术专家	获得了最多的ARM核的授权：M0、M0+、M3、M4、M7、ARM9、A7, A8、A9…超过1000个基于ARM核的产品
广阔的MCU产品组合	在工业领域的产品线上，从性能、存储、外设资源等方面拥有最丰富的选择
完善的开发工具	将基本的ARM开发工具应用于 Kinetis 及 LPC 系列，并扩展出许多新的特性
领先的生态环境	与业界领先的合作伙伴通力协作，提供从开发板到操作系统，再到多种协议栈的支持，共同助力客户的产品设计
以客户为中心	继续坚持做最好的客户支持模式，向客户提供最好的产品，最优的服务

世界范围及中国MCU的排名Y2015

MCU 全球排名

2015 Rank	Company Name	2015 Revenue($)
1	Renesas Electronics Corp	3,138
2	New NXP	3,017
3	Microchip + Atmel	2,093
4	Infineon Technologies	1,504
5	ST Microelectronics	1,504
6	Texas Instruments	1,206
7	Cypress Semiconductor	675
8	Samsung	376
9	Toshiba	193

通用 MCU 全球排名

2015 Rank	Company Name	2015 Revenue($)
1	Microchp + Atmel	1,763
2	Renasas	1,299
3	New NXP	902
4	ST Microelectronics	796
5	Texas Instruments	713
6	Cypress Semiconductor	486
7	Infineon	190
8	Silicon Labs	151
9	Toshiba	140

* Exclude all ASSP (Auto, etc.)

通用 MCU 中国排名

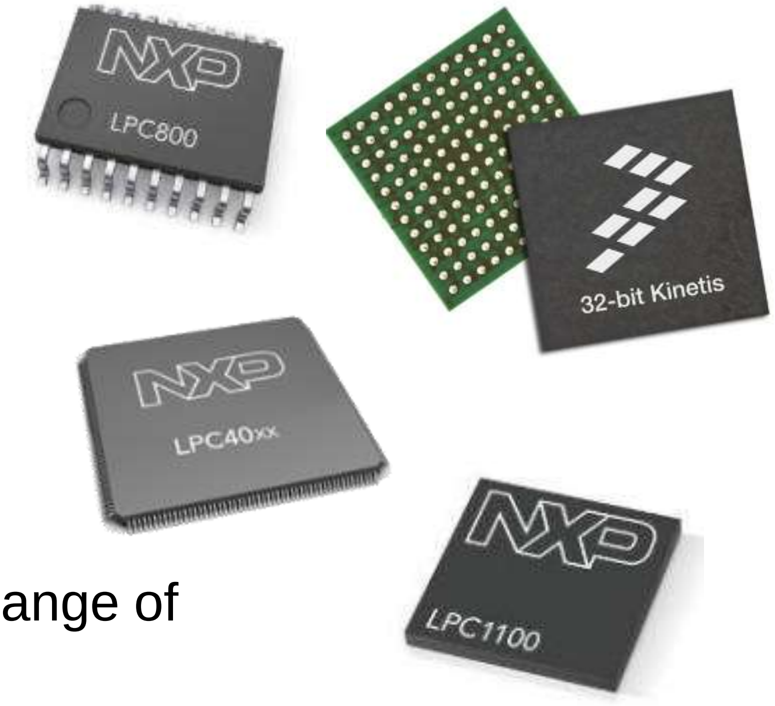
2015 Rank	Company Name	MS%
1	New NXP	37%
2	ST Microelectronics	36%
3	Nuvoton	6%
4	Atmel	4%
5	Silicon Labs	2%
6	Infineon	2%
7	Texas Instruments	2%
8	Spansion	2%
9	Others	8%

* Exclude all ASSP (Auto, etc.)

** Data source: IHS & IHS China*

Strength in Product Longevity
长生命周期支持

- NXP (both NXP LPC and former Freescale) have longstanding records of **providing long-term production support** for our products
- NXP has a **formal product longevity program** for the market segments we serve
  - For the automotive and medical segments, NXP will make a broad range of solutions available for a minimum of **15 years**
  - For all other market segments in which NXP participates, NXP will make a broad range of solutions available for a minimum of **10 years**
  - **Life cycles** begin at the time of launch
  - Includes NXP’s standard end-of-life notification policy
- For a complete list of participating products, visit, nxp.com/productlongevity



MCU生态环境支持

操作系统及软件协议栈

NXP Solutions:

Kinetis SDK/LPCOpen
- Drivers
- System Services
- FreeRTOS
- USB
- TCP/IP
- Filesystem

MQX PEG

Kinetis Bootloader

RTOS, Middleware Partners:

freeRTOS Micrium ARM mbed Green Hills SOFTWARE SEGGER www.segger.com wolfSSL expresslogic

Comprehensive frameworks and solutions for low-power, connected, and secure embedded systems

软件开发工具

IDE / Toolchains:

LPCXPRESSO IAR SYSTEMS Kinetis Design Studio freescale ARM KEIL Microcontroller Tools SOMNIUM DRT atollic

Software Configuration:

Kinetis Expert
- Power Estimation
- BSP Tools
- Project Generator
- Power Analyzer

PEG Processor Expert Software freescale

Industry leading IDE support and intuitive software configuration tools to accelerate application development

硬件评估板

Evaluation Kits:

LPC Xpresso

Freedom Development Platform

Tower System

Partner Solutions

SEGGER www.segger.com PE micro iSYSTEM LAUTERBACH DEVELOPMENT TOOLS

LPC-Link2

Low cost hardware platforms for evaluation and application development. Partner solutions for hardware debugging solutions

特定应用

HomeKit

- HomeKit SDK
- Motor Control
- Wireless Charging
- Sensor Fusion
- MFi
- PEG GUI
- POS / EMV

Connectivity Solutions

Bluetooth SMART 6LoWPAN EtherNet WiFi THREAD GROUP 802.15.4

Software frameworks and development tools for targeted applications and certified connectivity solutions

在线及现场支持服务

Broad Market:

- OOB Walkthroughs
- NXP Community
- Embedded Blogs
- Kinetis Designs
- Kinetis Tutorials
- Application Notes
- Symbols & Footprints

High Touch:

- Professional Support
- Professional Services

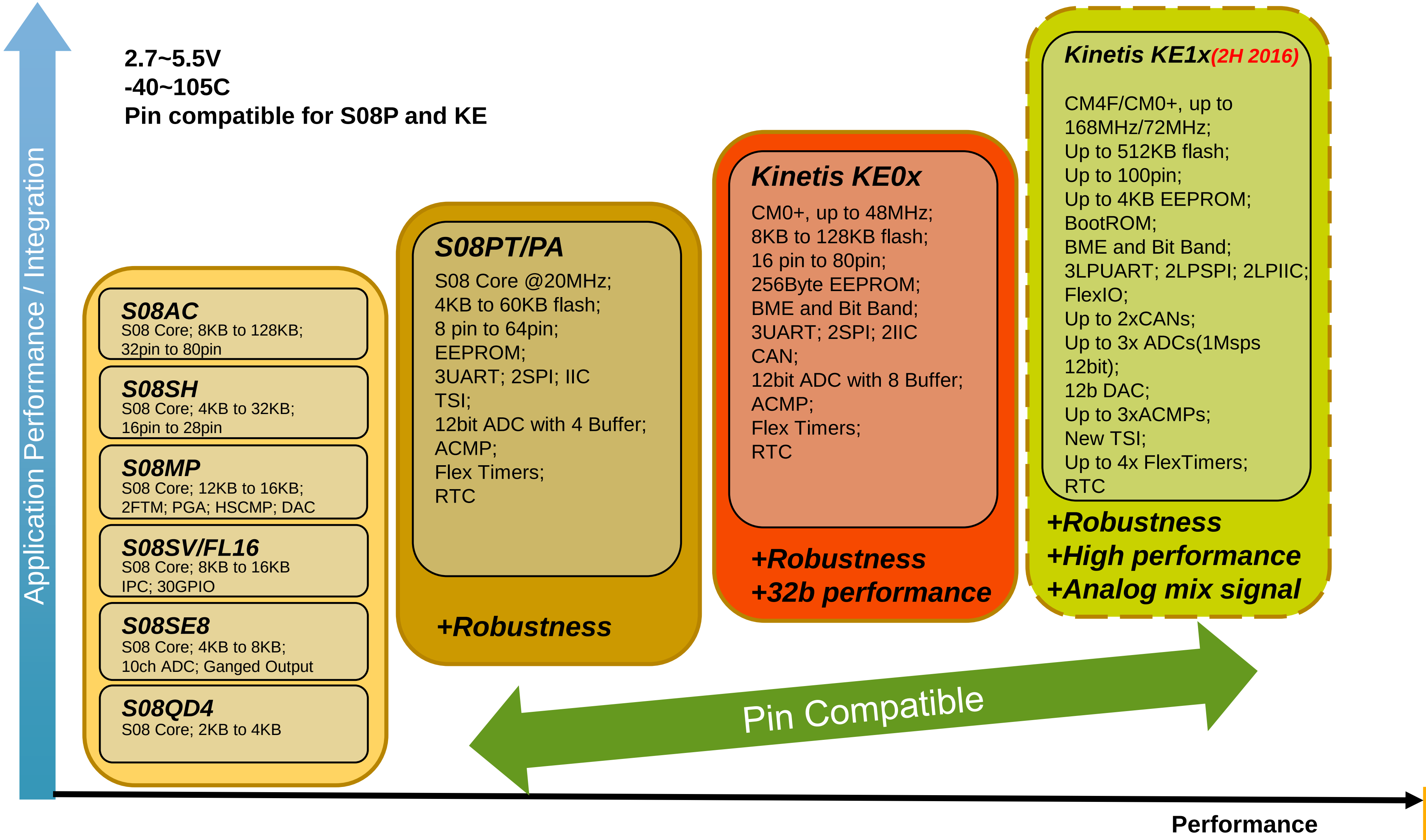
Get started quickly and get the support you need, when you need it

New KE1x Series

- **提供更多内存**资源，更多外设特性以及更强处理性能的5V Kinetis E系列家族

KINETIS E 路标

5V产品线的历史及产品更新



2.7~5.5V
-40~105C
Pin compatible for S08P and KE

S08AC
S08 Core; 8KB to 128KB;
32pin to 80pin

S08SH
S08 Core; 4KB to 32KB;
16pin to 28pin

S08MP
S08 Core; 12KB to 16KB;
2FTM; PGA; HSCMP; DAC

S08SV/FL16
S08 Core; 8KB to 16KB
IPC; 30GPIO

S08SE8
S08 Core; 4KB to 8KB;
10ch ADC; Ganged Output

S08QD4
S08 Core; 2KB to 4KB

S08PT/PA
S08 Core @20MHz;
4KB to 60KB flash;
8 pin to 64pin;
EEPROM;
3UART; 2SPI; IIC
TSI;
12bit ADC with 4 Buffer;
ACMP;
Flex Timers;
RTC

+Robustness

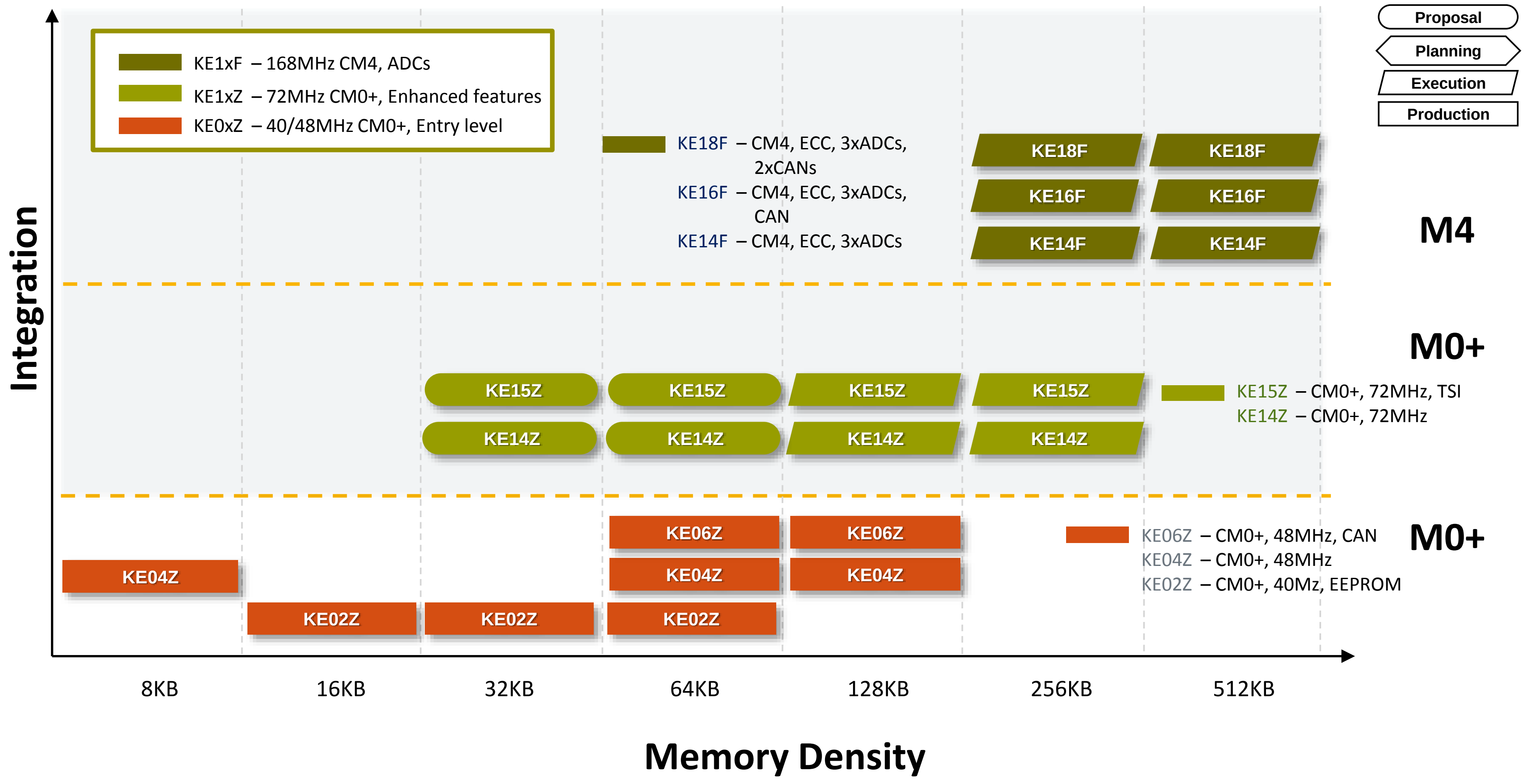
Kinetis KE0x
CM0+, up to 48MHz;
8KB to 128KB flash;
16 pin to 80pin;
256Byte EEPROM;
BME and Bit Band;
3UART; 2SPI; 2IIC
CAN;
12bit ADC with 8 Buffer;
ACMP;
Flex Timers;
RTC

+Robustness
+32b performance

Kinetis KE1x(2H 2016)
CM4F/CM0+, up to
168MHz/72MHz;
Up to 512KB flash;
Up to 100pin;
Up to 4KB EEPROM;
BootROM;
BME and Bit Band;
3LPUART; 2LPSPI; 2LPIIC;
FlexIO;
Up to 2xCANs;
Up to 3x ADCs(1Msps
12bit);
12b DAC;
Up to 3xACMPs;
New TSI;
Up to 4x FlexTimers;
RTC

+Robustness
+High performance
+Analog mix signal

Kinetis E 系列的产品家族



🟫 KE1xF – 168MHz CM4, ADCs
🟩 KE1xZ – 72MHz CM0+, Enhanced features
🟧 KE0xZ – 40/48MHz CM0+, Entry level

Proposal
Planning
Execution
Production

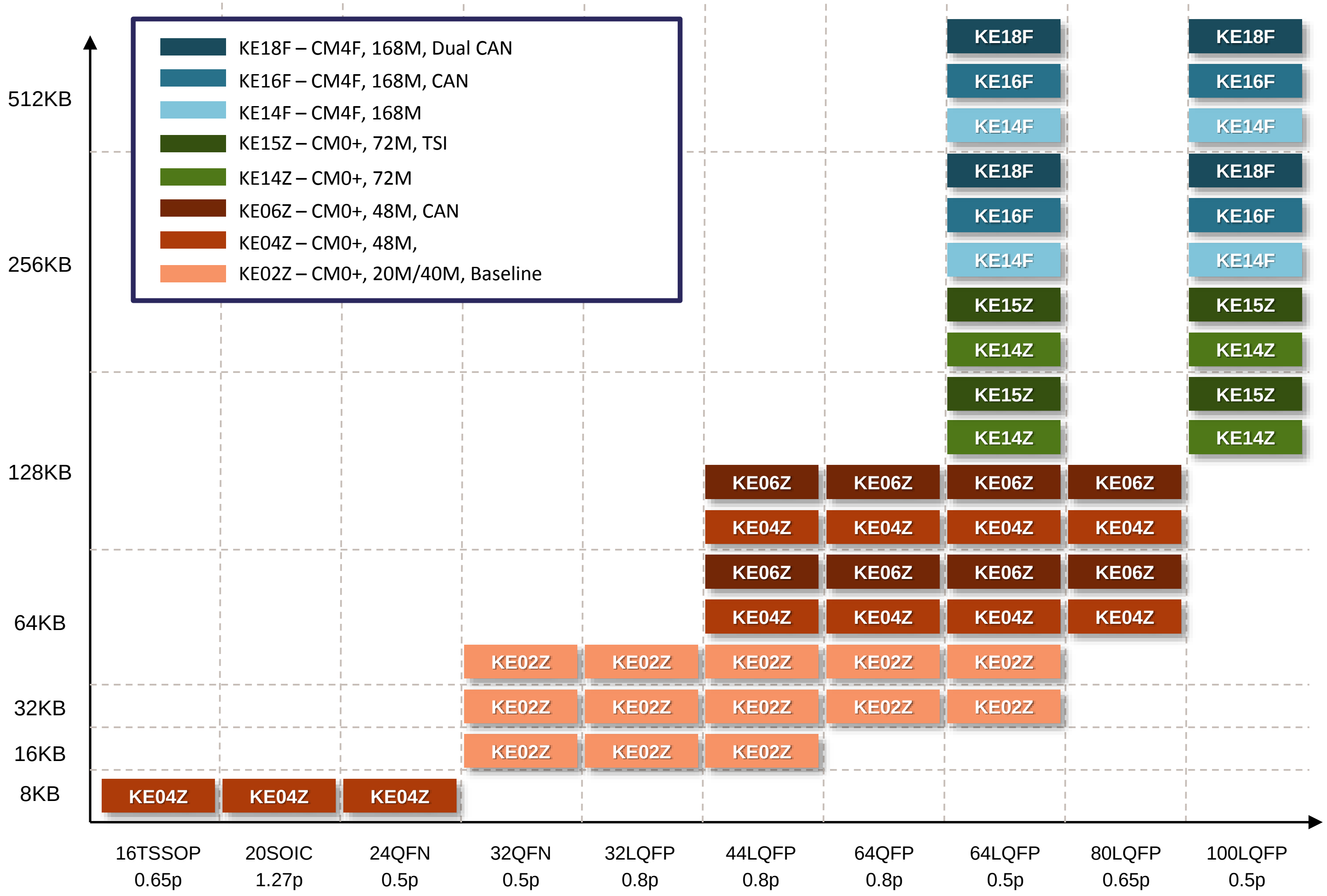
🟫 KE18F – CM4, ECC, 3xADCs, 2xCANs
KE16F – CM4, ECC, 3xADCs, CAN
KE14F – CM4, ECC, 3xADCs

🟩 KE15Z – CM0+, 72MHz, TSI
KE14Z – CM0+, 72MHz

🟧 KE06Z – CM0+, 48MHz, CAN
KE04Z – CM0+, 48MHz
KE02Z – CM0+, 40Mz, EEPROM

	8KB	16KB	32KB	64KB	128KB	256KB	512KB
M4						KE18F	KE18F
						KE16F	KE16F
						KE14F	KE14F
M0+			KE15Z	KE15Z	KE15Z	KE15Z	
			KE14Z	KE14Z	KE14Z	KE14Z	
M0+				KE06Z	KE06Z		
	KE04Z			KE04Z	KE04Z		
		KE02Z	KE02Z	KE02Z			

基于封装及内存大小分类



- KE18F – CM4F, 168M, Dual CAN
- KE16F – CM4F, 168M, CAN
- KE14F – CM4F, 168M
- KE15Z – CM0+, 72M, TSI
- KE14Z – CM0+, 72M
- KE06Z – CM0+, 48M, CAN
- KE04Z – CM0+, 48M,
- KE02Z – CM0+, 20M/40M, Baseline

	16TSSOP 0.65p	20SOIC 1.27p	24QFN 0.5p	32QFN 0.5p	32LQFP 0.8p	44LQFP 0.8p	64QFP 0.8p	64LQFP 0.5p	80LQFP 0.65p	100LQFP 0.5p
512KB								KE18F KE16F KE14F		KE18F KE16F KE14F
256KB								KE18F KE16F KE14F KE15Z KE14Z		KE18F KE16F KE14F KE15Z KE14Z
128KB						KE06Z KE04Z	KE06Z KE04Z	KE15Z KE14Z KE06Z KE04Z	KE06Z KE04Z	KE15Z KE14Z
64KB				KE02Z	KE02Z	KE06Z KE04Z KE02Z	KE06Z KE04Z KE02Z	KE06Z KE04Z KE02Z	KE06Z KE04Z	
32KB				KE02Z	KE02Z	KE02Z	KE02Z	KE02Z		
16KB				KE02Z	KE02Z	KE02Z				
8KB	KE04Z	KE04Z	KE04Z							

- 2.7~5.5V, -40 to +105C
- High EMC/ESD robustness
- Pin compatible within Kinetis E

KE0xZ产品特性

Key Features:

Core/System
- ARM® Cortex®-M0+ up to 48MHz

Memory
- up to 128KB Flash
- up to 16KB SRAM
- up to 256B EEPROM

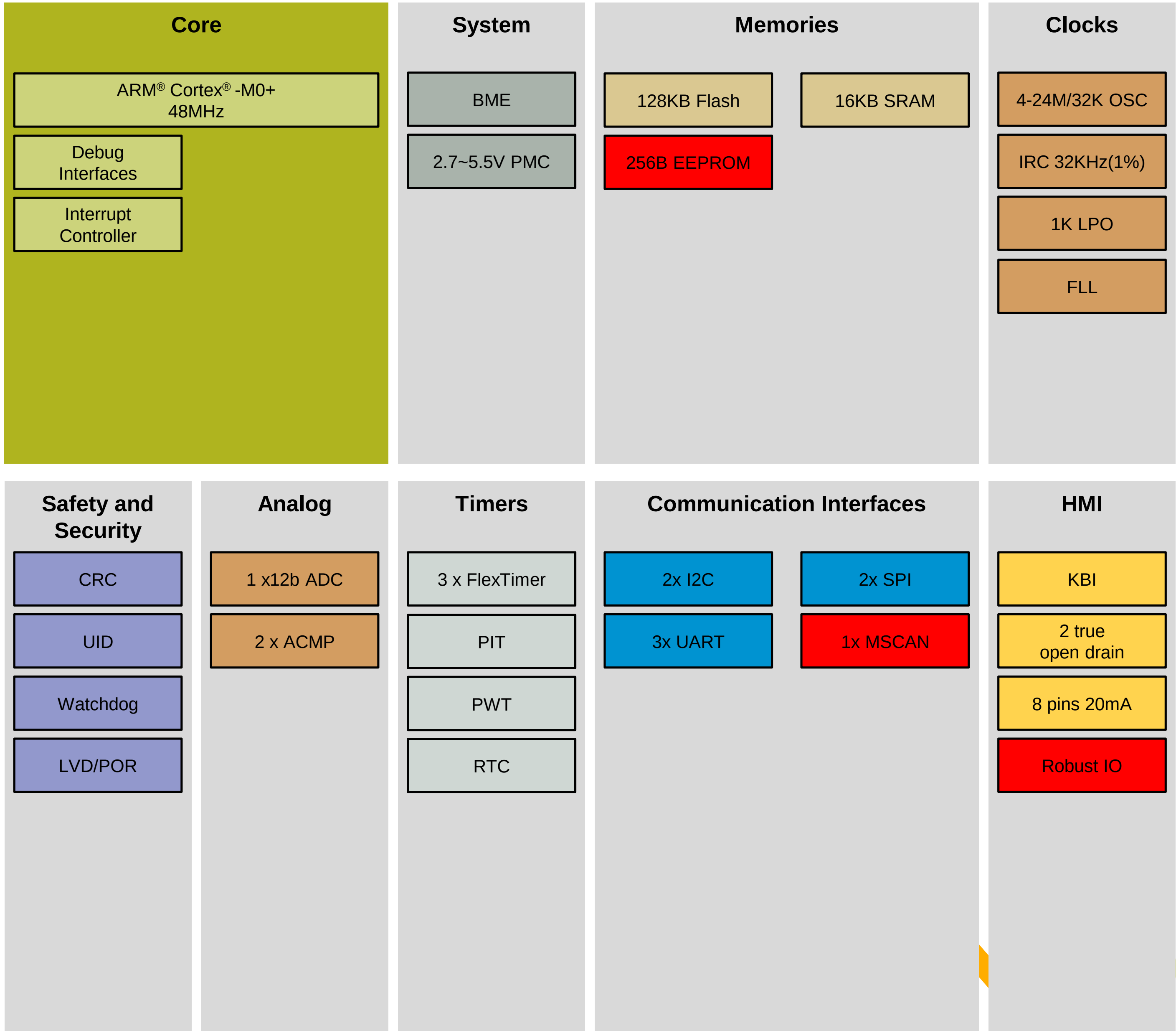
Communications
- 1 x MSCAN
- 3 x UART / 2 x SPI / 2 x I2C

Analog
- 1 x 12b ADC
- 2 x ACMP

Timers
- 1 x 6ch FTM (PWM)
- 2 x 2ch FTM (PWM)
- 1 x PIT / 1 x PWT
- RTC

Others
- Up to 71 I/Os
- 2.7-5.5V, -40 to 105ºC

Packages: 80LQFP(0.65mm pitch)
64LQFP(0.5mm pitch)
64QFP(0.8mm pitch)
44LQFP(0.8mm pitch)
32LQFP(0.8mm pitch)
32QFN(0.5mm pitch)
24QFN(0.5mm pitch)
20SOIC(1.27mm pitch)
16TSSOP(0.65mm pitch)
Pin compatible within KE



Core
- ARM® Cortex® -M0+ 48MHz
- Debug Interfaces
- Interrupt Controller

System
- BME
- 2.7~5.5V PMC

Memories
- 128KB Flash
- 16KB SRAM
- 256B EEPROM

Clocks
- 4-24M/32K OSC
- IRC 32KHz(1%)
- 1K LPO
- FLL

Safety and Security
- CRC
- UID
- Watchdog
- LVD/POR

Analog
- 1 x12b ADC
- 2 x ACMP

Timers
- 3 x FlexTimer
- PIT
- PWT
- RTC

Communication Interfaces
- 2x I2C
- 2x SPI
- 3x UART
- 1x MSCAN

HMI
- KBI
- 2 true open drain
- 8 pins 20mA
- Robust IO

KE1xZ产品特性

Key Features:

Core/System
- ARM® Cortex® -M0+ up to 72MHz
- 8ch eDMA
- TRGMUX
- MMDVSQ

Memory
- up to 256KB Flash
- up to 32KB SRAM
- up to 32KB FlexMemory / 2KB EEPROM
- Boot ROM

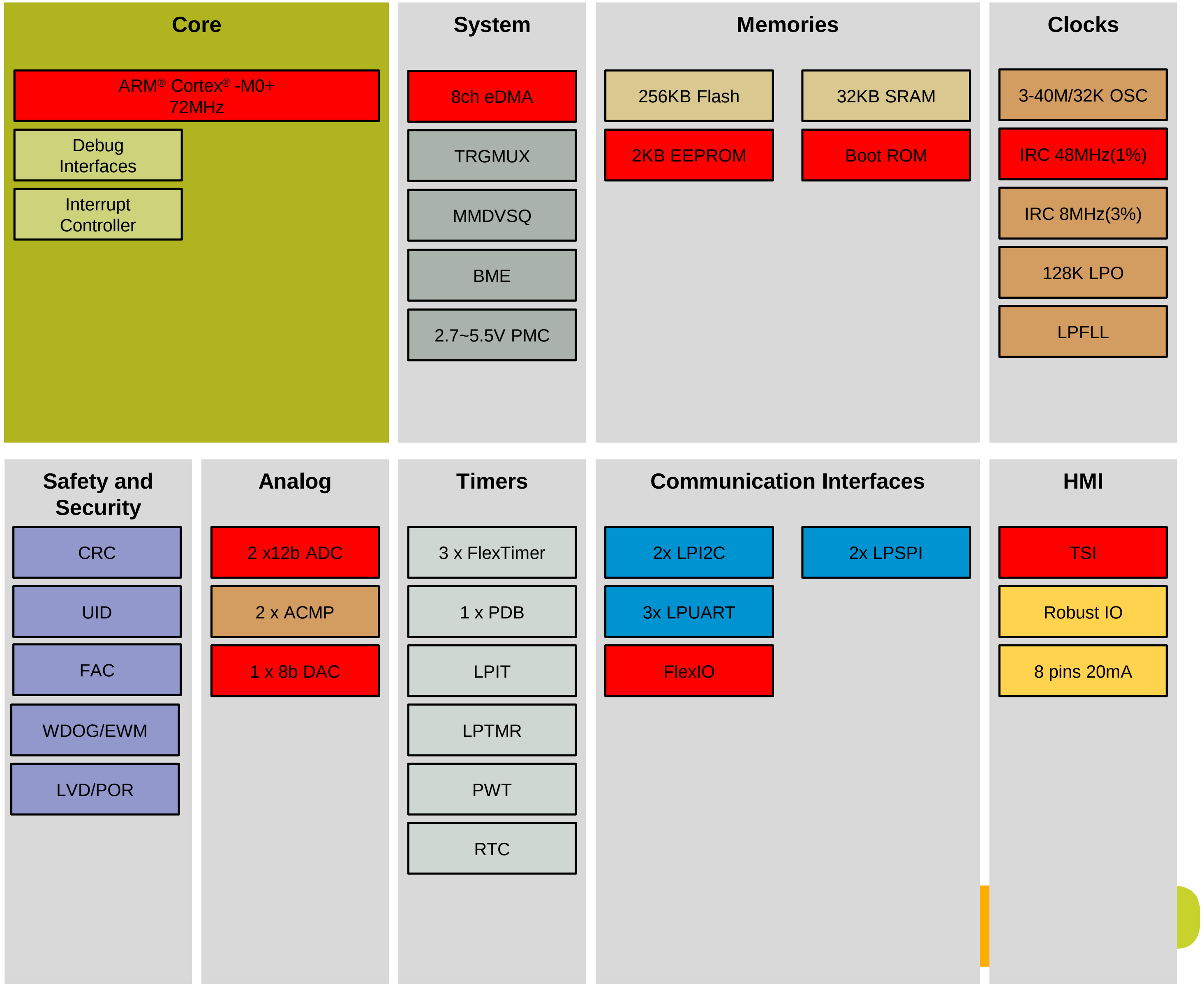
Communications
- 3 x LPUART / 2 x LPSPI / 2 x LPI2C / FlexIO

Analog
- 2 x 12b ADC, 1MSPS
- 2 x ACMP
- 1 x 8b DAC

Timers
- 1 x 8ch FTM (PWM)
- 2 x 4ch FTM (PWM/Quad Dec.)
- 1 x PDB
- 1 x 4ch LPIT / 1 x LPTMR / 1 x PWT
- 1 x RTC

Others
- Up to 36 keys TSI
- Up to 89 GPIO with glitch filter
- 2.7-5.5V, -40 to 105ºC

Packages: 100LQFP(0.5mm pitch)
64LQFP(0.5mm pitch)
Pin compatible within KE



Core
ARM® Cortex® -M0+ 72MHz
Debug Interfaces
Interrupt Controller

System
8ch eDMA
TRGMUX
MMDVSQ
BME
2.7~5.5V PMC

Memories
256KB Flash
32KB SRAM
2KB EEPROM
Boot ROM

Clocks
3-40M/32K OSC
IRC 48MHz(1%)
IRC 8MHz(3%)
128K LPO
LPFLL

Safety and Security
CRC
UID
FAC
WDOG/EWM
LVD/POR

Analog
2 x12b ADC
2 x ACMP
1 x 8b DAC

Timers
3 x FlexTimer
1 x PDB
LPIT
LPTMR
PWT
RTC

Communication Interfaces
2x LPI2C
2x LPSPI
3x LPUART
FlexIO

HMI
TSI
Robust IO
8 pins 20mA

KE1xF 产品特性

Key Features:

Core/System
- ARM® Cortex® -M4F up to 168MHz
- 16ch eDMA
- TRGMUX
- MPU

Memory
- up to 512KB Flash with ECC
- up to 64KB SRAM with ECC
- up to 64K FlexMemory / 4KB EEPROM
- 8KB I/D Cache
- Boot ROM

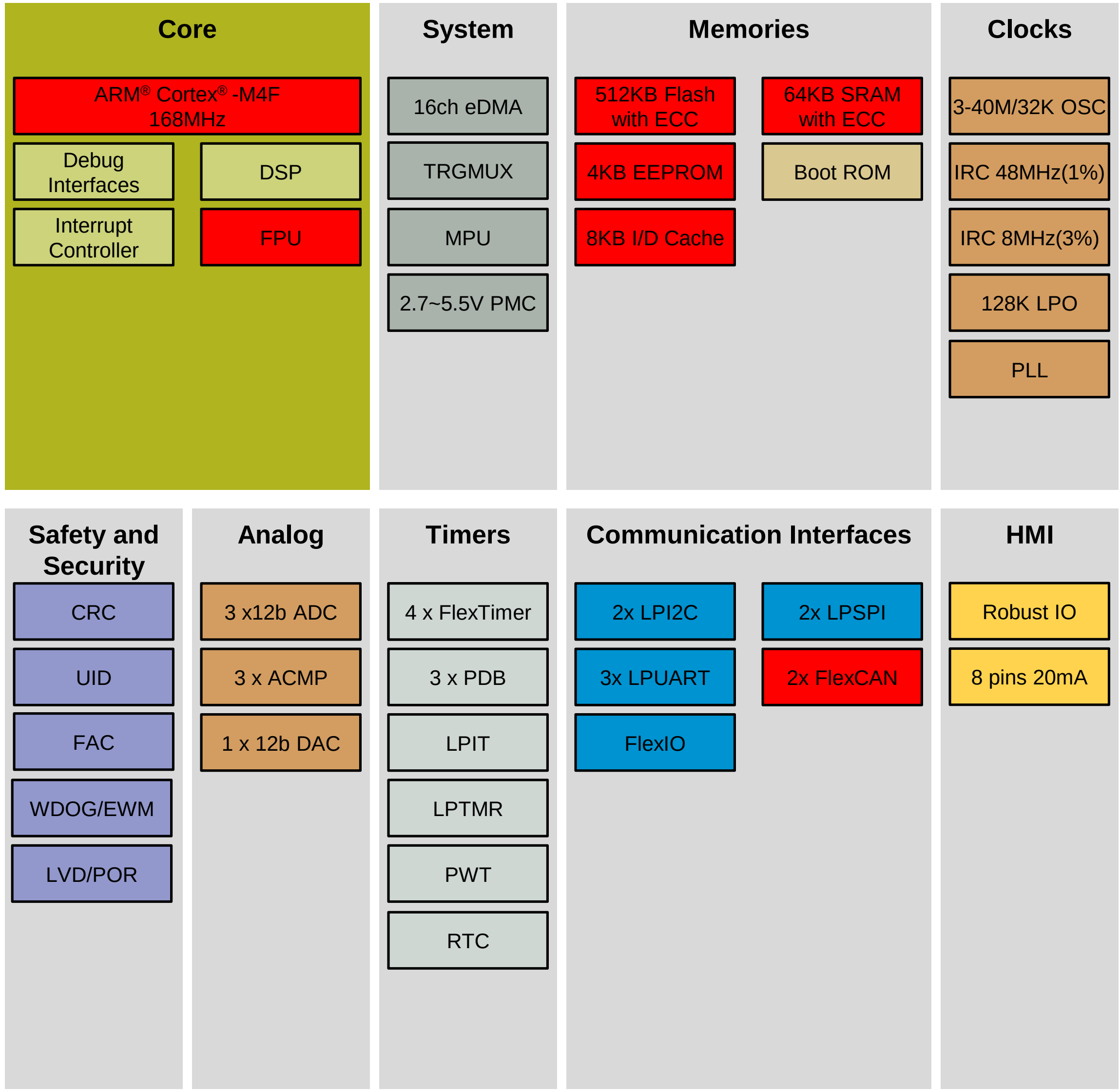
Communications
- 2 x FlexCAN
- 3 x LPUART / 2 x LPSPI / 2 x LPI2C / FlexIO

Analog
- 3 x 12b ADC, 1MSPS
- 3 x ACMP
- 1 x 12b DAC

Timers
- 2 x 8ch FTM (PWM)
- 2 x 8ch FTM (PWM/Quad Dec.)
- 3 x PDB
- 1 x 4ch LPIT / 1 x LPTMR / 1 x PWT
- 1 x RTC

Others
- Up to 89 GPIO with glitch filter
- 2.7-5.5V, -40 to 105ºC

Packages: 100LQFP(0.5mm pitch)
64LQFP(0.5mm pitch)
Pin compatible within KE



Core
- ARM® Cortex® -M4F 168MHz
- Debug Interfaces
- DSP
- Interrupt Controller
- FPU

System
- 16ch eDMA
- TRGMUX
- MPU
- 2.7~5.5V PMC

Memories
- 512KB Flash with ECC
- 64KB SRAM with ECC
- 4KB EEPROM
- Boot ROM
- 8KB I/D Cache

Clocks
- 3-40M/32K OSC
- IRC 48MHz(1%)
- IRC 8MHz(3%)
- 128K LPO
- PLL

Safety and Security
- CRC
- UID
- FAC
- WDOG/EWM
- LVD/POR

Analog
- 3 x12b ADC
- 3 x ACMP
- 1 x 12b DAC

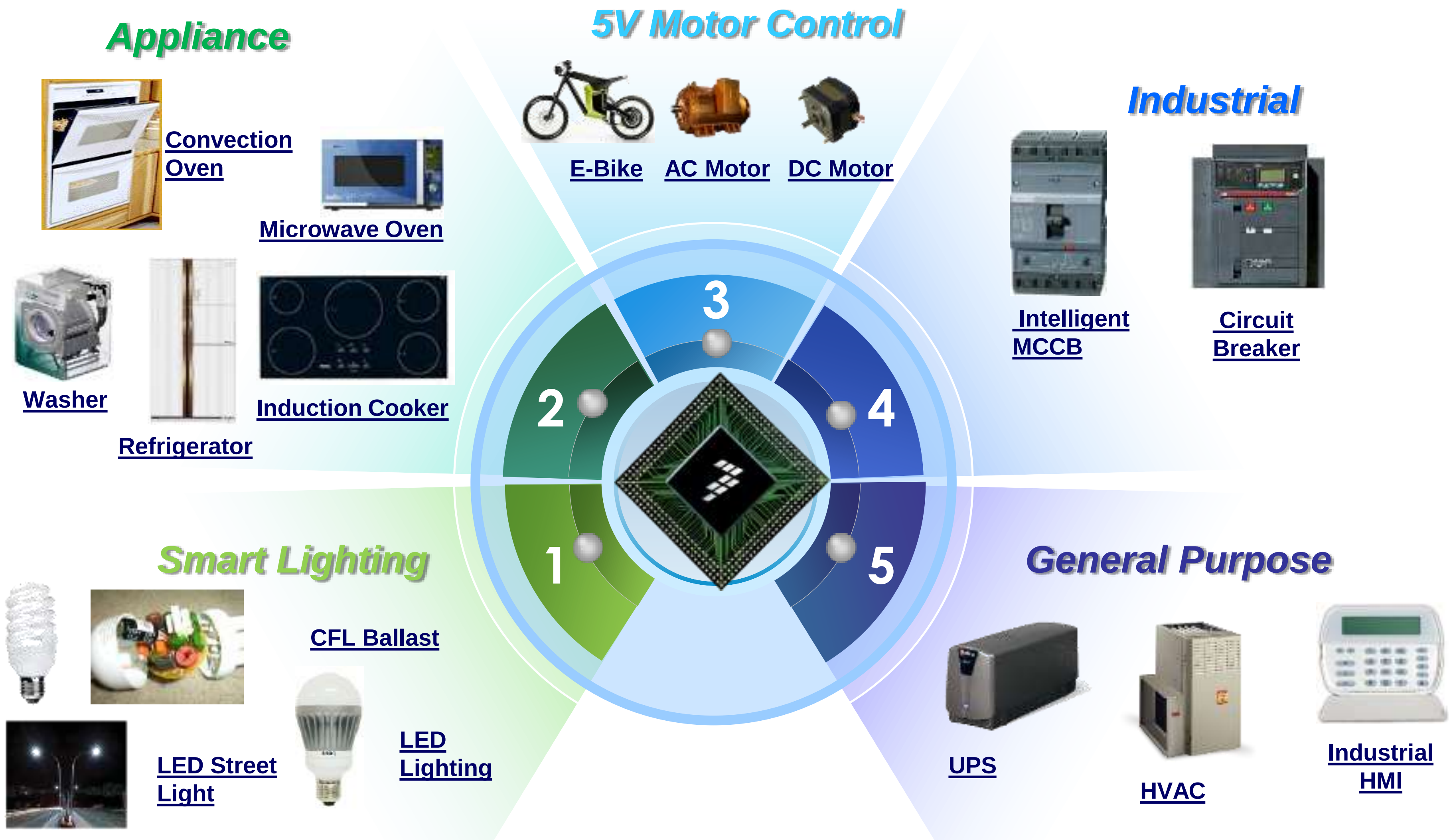
Timers
- 4 x FlexTimer
- 3 x PDB
- LPIT
- LPTMR
- PWT
- RTC

Communication Interfaces
- 2x LPI2C
- 2x LPSPI
- 3x LPUART
- 2x FlexCAN
- FlexIO

HMI
- Robust IO
- 8 pins 20mA

KE1X 典型应用

Kinetis E Series 目标市场及典型应用



Appliance

Convection Oven

Microwave Oven

Washer

Refrigerator

Induction Cooker

5V Motor Control

E-Bike

AC Motor

DC Motor

Industrial

Intelligent MCCB

Circuit Breaker

Smart Lighting

CFL Ballast

LED Street Light

LED Lighting

General Purpose

UPS

HVAC

Industrial HMI

KE1X 关键特性

强抗干扰、安全特性

Feature category	Description
I/O强抗干扰	I/O支持5V电压输入输出，并带有数字滤波功能
安全运行库	提供自有的符合IEC60730 class B标准的安全库
带有ECC检查的RAM [1]	SRAM拥有ECC错误纠正功能，单bit错校正、双bit错检测
带有ECC检查的Flash [1]	Flash拥有ECC错误纠正功能，单bit错校正、双bit错检测
CRC校验	支持16bit/32bit的基于可编程多项式的CRC校验
片上看门狗	拥有内部看门狗，并支持内部时钟
时钟失锁监视器	片上集成时钟失锁监视器，监视外部时钟是否正常，如果存在失锁现象，将产生中断预警或者复位
内存保护单元	专属的内存保护功能能够防止意外或者非法的内存访问
Flash访问控制	Flash 访问控制单元(FAC) 能够用于保护用户的代码不被窃取，保护软件知识产权
Flash 安全性	Flash安全选项，除了能够屏蔽外部对Flash内容的探测，同时也能防止Flash内容被误擦除。

[1]: KE1xF only

Robust & Safety – EMC 性能

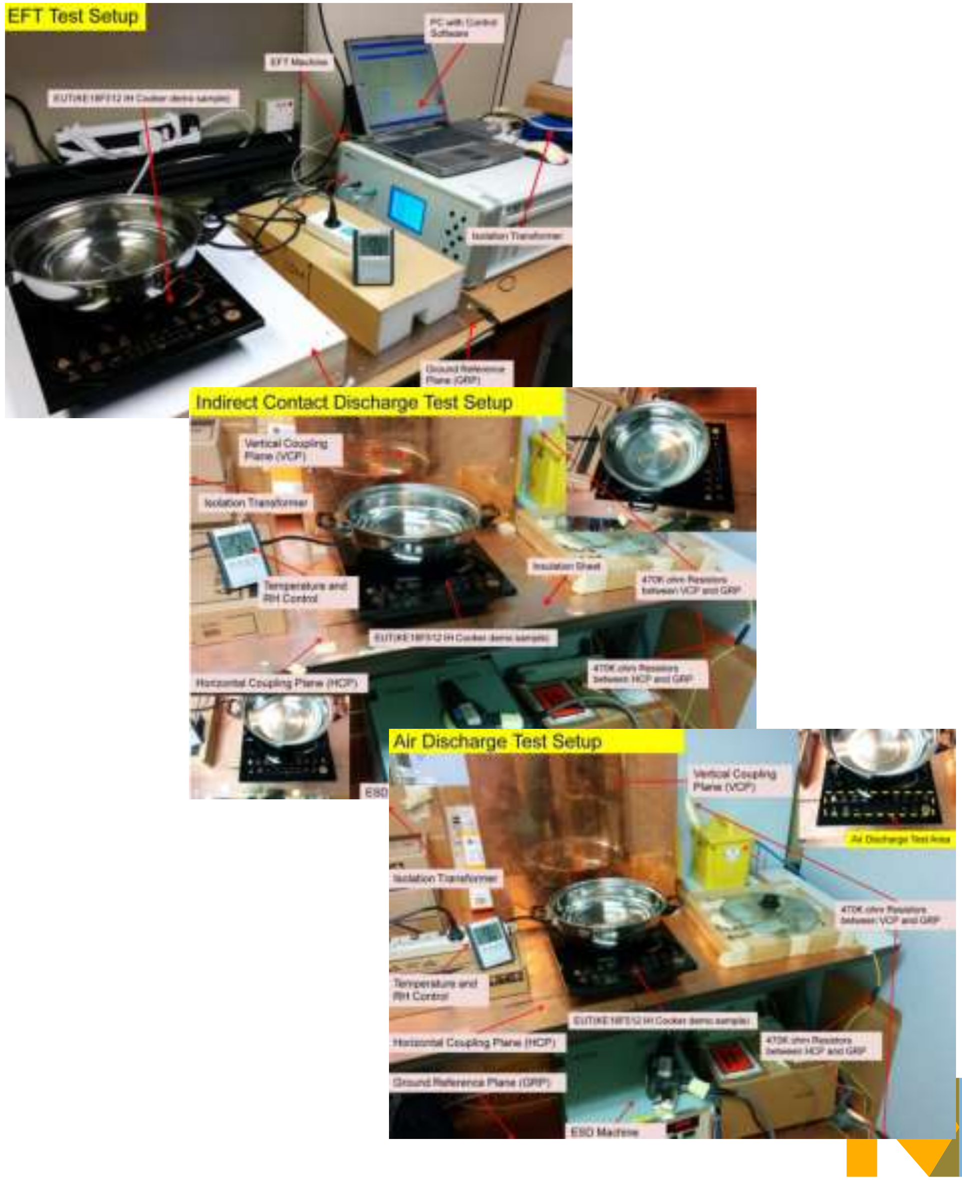
测试条件

- PKE18F512VLL15
- IH Cooker as the test platform
- System level tests based on
  - IEC 61000-4-4(EFT)
  - IEC 61000-4-2(ESD)

测试结果

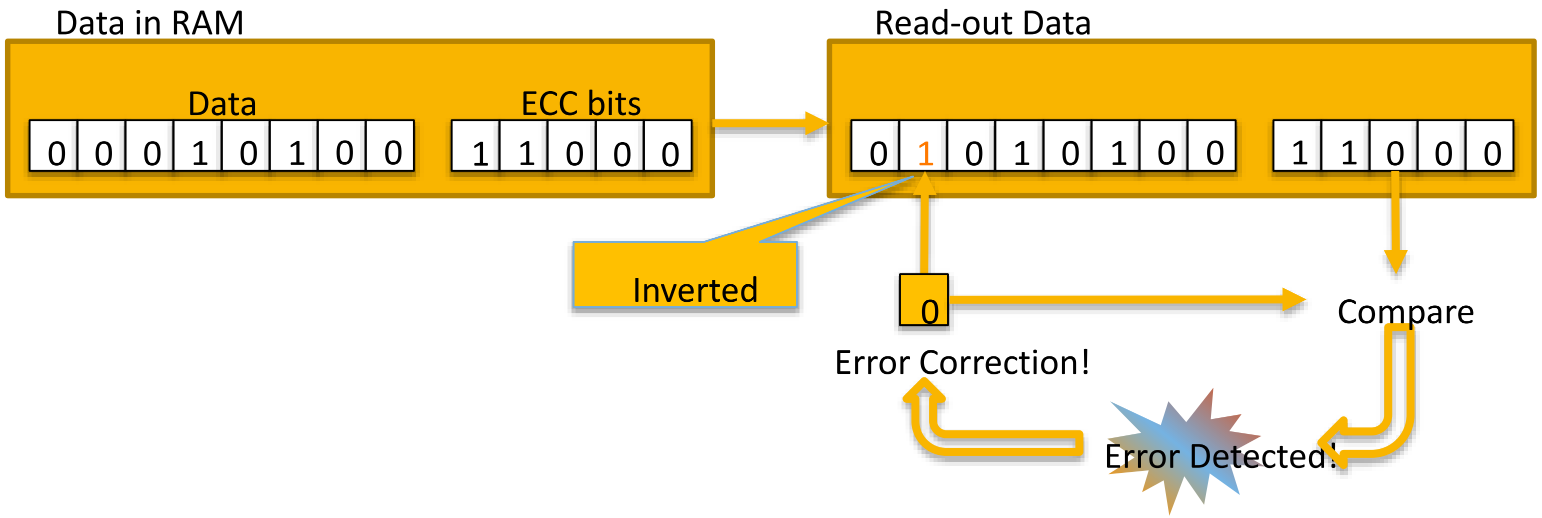
- System level
  - IEC 61000-4-4(EFT):+/- 4.5kV*
  - IEC 61000-4-2(ESD): Contact Discharge(at the case) +/- 20kV
  - IEC 61000-4-2(ESD): Air Discharge (at the control panel) +/- 15kV

*Limited by the test equipment max output voltage


EFT Test Setup
PC with Control Software
EFT Machine
EUT(KE18F512 IH Cooker demo sample)
Isolation Transformer
Ground Reference Plane (GRP)
Indirect Contact Discharge Test Setup
Vertical Coupling Plane (VCP)
Isolation Transformer
Temperature and RH Control
Insulation Sheet
470K ohm Resistors between VCP and GRP
EUT(KE18F512 IH Cooker demo sample)
Horizontal Coupling Plane (HCP)
470K ohm Resistors between HCP and GRP
ESD
Air Discharge Test Setup
Vertical Coupling Plane (VCP)
Air Discharge Test Area
Isolation Transformer
470K ohm Resistors between VCP and GRP
Temperature and RH Control
EUT(KE18F512 IH Cooker demo sample)
Horizontal Coupling Plane (HCP)
470K ohm Resistors between HCP and GRP
Ground Reference Plane (GRP)
ESD Machine

Robust & Safety – Error Correction Code[1]

- RAM ECC:
  - 8-bit data with 5-bits ECC
  - detect & correct up to 1-bit error
  - detect out up to 2-bits error support ECC bits self error check



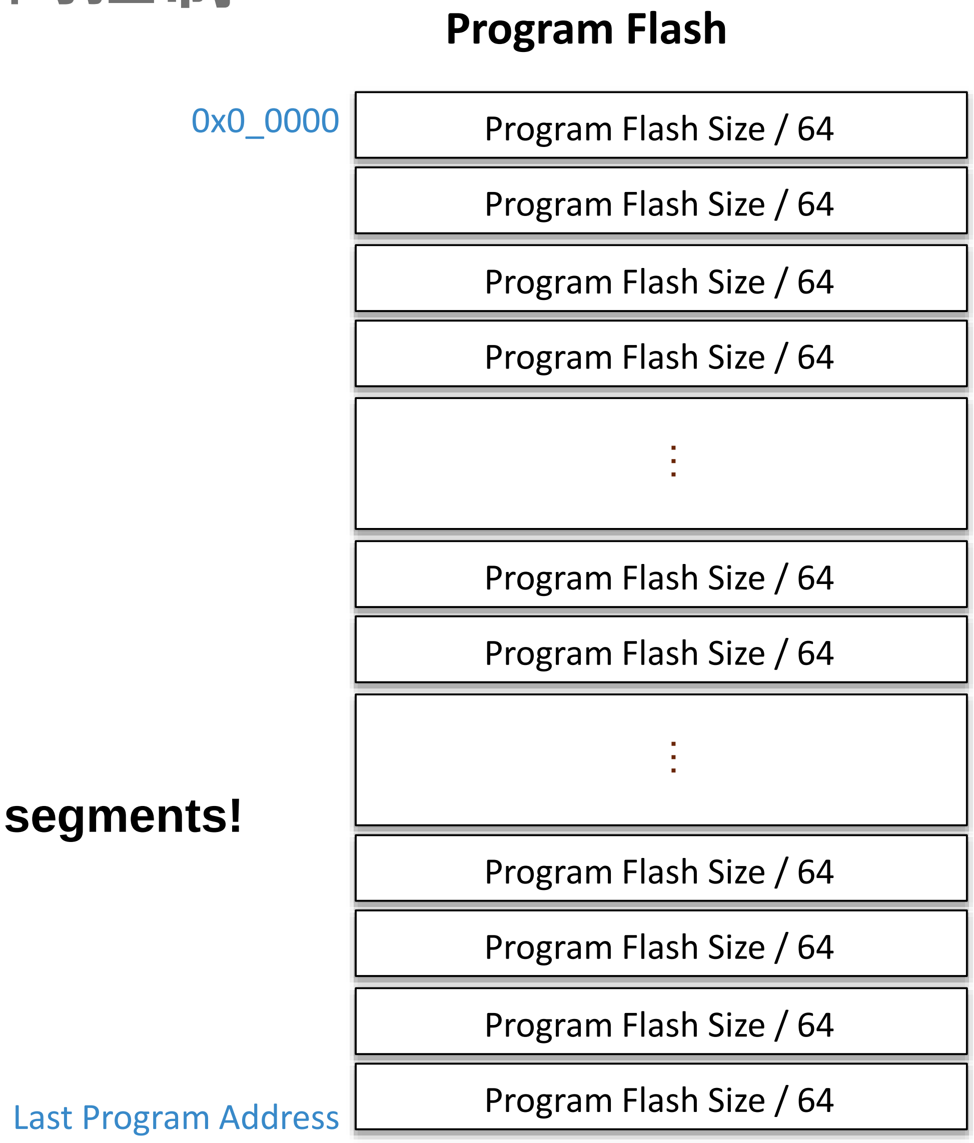
- Flash ECC:
  - 64-bit data with 8-bits ECC
  - detect & correct up to 1-bit error support ECC bits self error check

[1] KE1xF only

Robust & Safety – FAC- Flash访问控制

- 可编程的将Flash分段，最多64段，可对单独的段设置访问控制
- 多种安全状态:
  - Supervisor/privileged secure state – Execute & Modify
  - Mid-level state – Execute Only
  - Unsecure state – No Access Right
- 用户通过编程Program Once Area使能访问控制

Prevents unauthorized access to selected code segments!
阻止对指定memory区域的未授权的访问



Program Flash

0x0_0000

Program Flash Size / 64

Program Flash Size / 64

Program Flash Size / 64

Program Flash Size / 64

⋮

Program Flash Size / 64

Program Flash Size / 64

⋮

Program Flash Size / 64

Program Flash Size / 64

Program Flash Size / 64

Program Flash Size / 64

Last Program Address

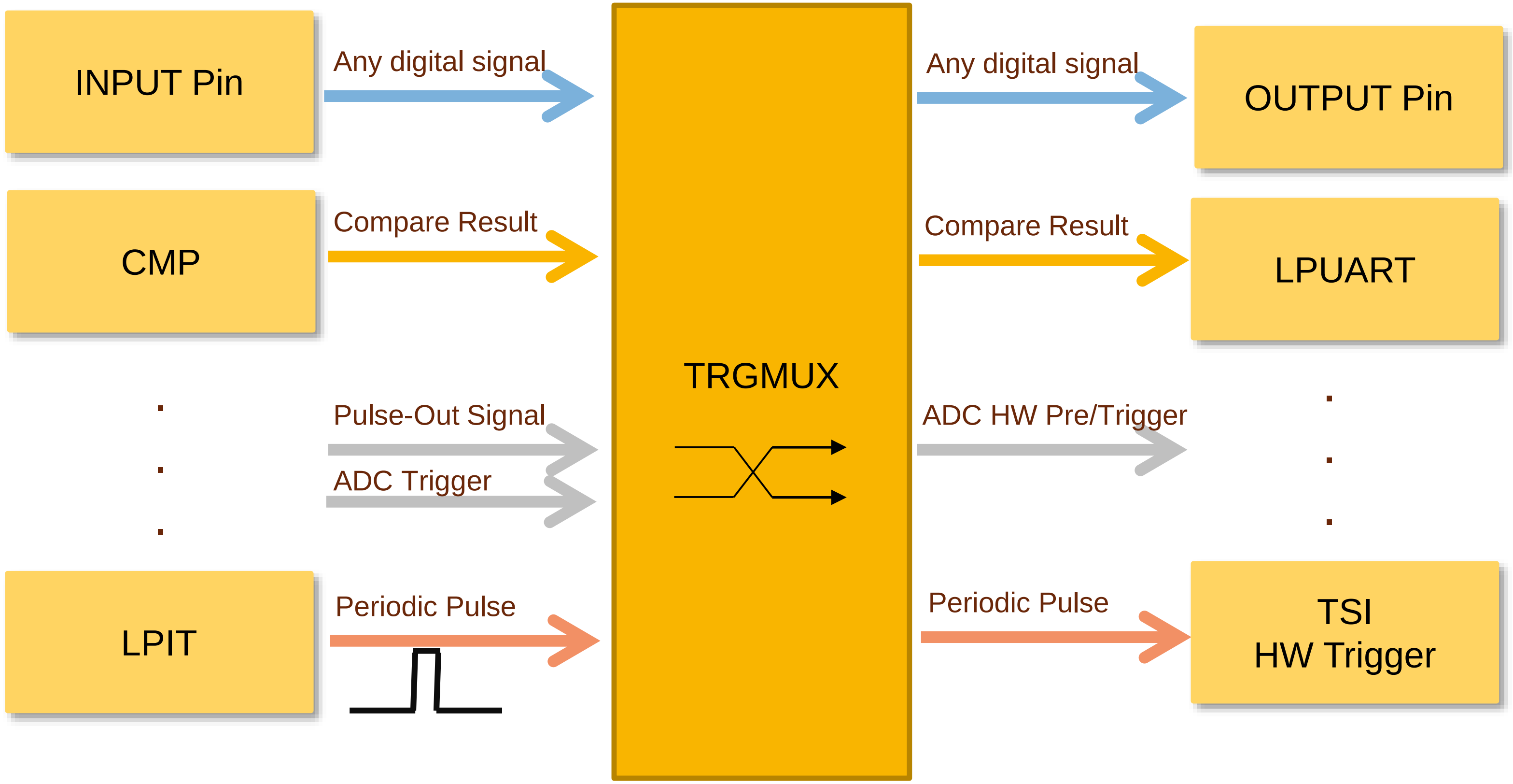
高性能及效率

Feature	Benefit to customer
High frequency CPU core	KE1xF, CM4 core runs up to 168MHz KE1xZ, CM0+ core runs up to 72MHz Improve system performance
8KB I/D Cache[1]	Improving the code and data access efficiency Improve system performance
MMDVSQ [2]	Hardware engine for math operation, reducing CPU workload
TRGMUX	Improve system performance, more flexible for internal connection
eDMA	Improve system performance, reducing power consumption and CPU workload

[1] KE1xF only
[2] KE1xZ only

Performance and Efficiency – 多路触发TRGMUX

灵活的内部逻辑触发及交互



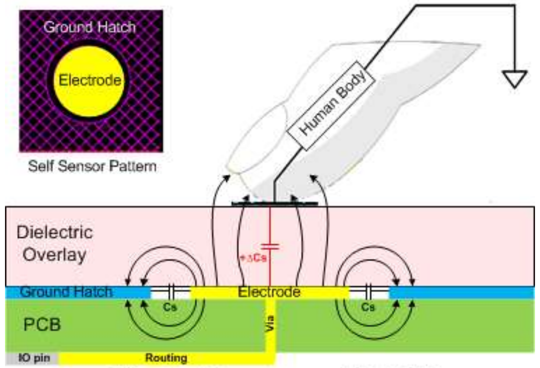
HMI

Feature	Benefit to customer
TSI触摸感应接口[1]	Up to 36 touch keys Pass IEC61000-4-6 test, enhanced EMC/waterproof performance Supports both self-cap and mutual-cap sensing mode
大电流驱动IO	8 high drive pins offer maximum 20mA driver current each
更多的IO数量	More control signal Input/Output More flexible hardware design Up to 89 GPIOs on 100LQFP, 58 GPIOs on 64LQFP

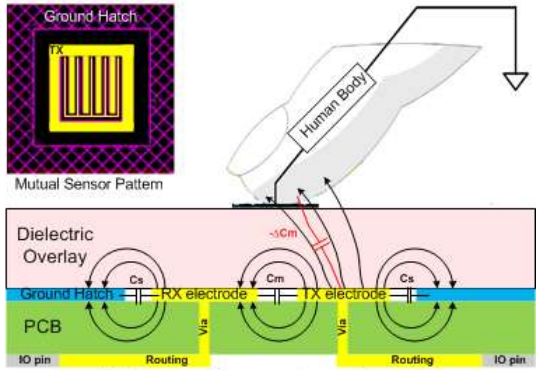
[1]: KE15Z only

HMI – 触摸感应接口

- 自容感测 Mode
  - 简单成熟的电极设计
  - 通道间串扰较少
  - 单点感应，可应用于按键、滑条、滚轮等多种外形设计
- 互容感测 Mode
  - 拥有良好的灵敏度
  - 按键用于矩阵外形，布线方便
  - 可用于单点及多点感应
- High Performance in EMC
  - IEC61000-4-6 Certification by GRGTest
  - IEC61000-4-6 Certification by AUDIX



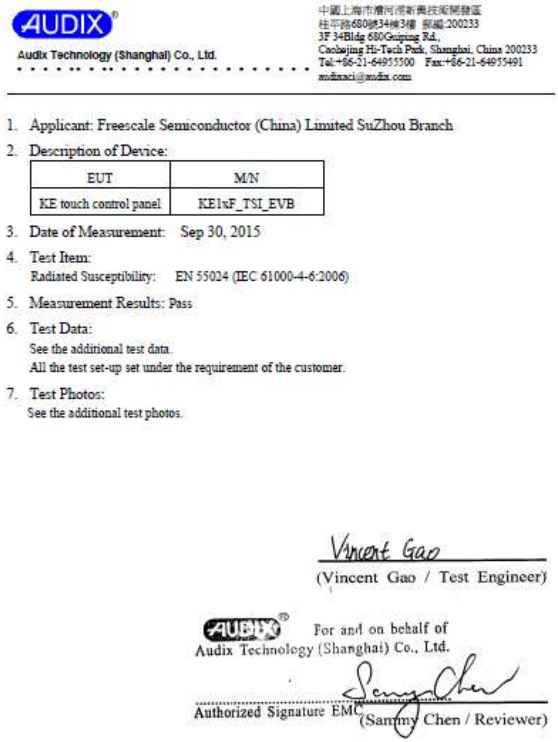
Self-cap Touch Sensor structure and Electric field



Mutual-cap Touch Sensor structure and Electric field

TSI Value Features

□ Two operation modes
  Self-cap: up to 25 keys
  Mutual: up to 36 key
□ Advanced robust in EMC
  Pass IEC61000-4-6 standard test
□ Advanced robust in waterproof
□ High sensitivity and resolution
□ No need for CPU interfere
□ Ease of use
  NXP Touch Library support
  SDK touch APIs support
□ No need for external components



AUDIX®
Audix Technology (Shanghai) Co., Ltd.

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Caohejing Hi-Tech Park, Shanghai, China 200233
Tel:+86-21-64955500 Fax:+86-21-64955491
audixsci@audix.com

1. Applicant: Freescale Semiconductor (China) Limited SuZhou Branch
2. Description of Device:

EUT	M/N
KE touch control panel	KE1xF_TSI_EVB

3. Date of Measurement: Sep 30, 2015
4. Test Item:
   Radiated Susceptibility: EN 55024 (IEC 61000-4-6:2006)
5. Measurement Results: Pass
6. Test Data:
   See the additional test data.
   All the test set-up set under the requirement of the customer.
7. Test Photos:
   See the additional test photos.

Vincent Gao
(Vincent Gao / Test Engineer)

AUDIX® For and on behalf of
Audix Technology (Shanghai) Co., Ltd.

Sammy Chen
Authorized Signature EMC (Sammy Chen / Reviewer)

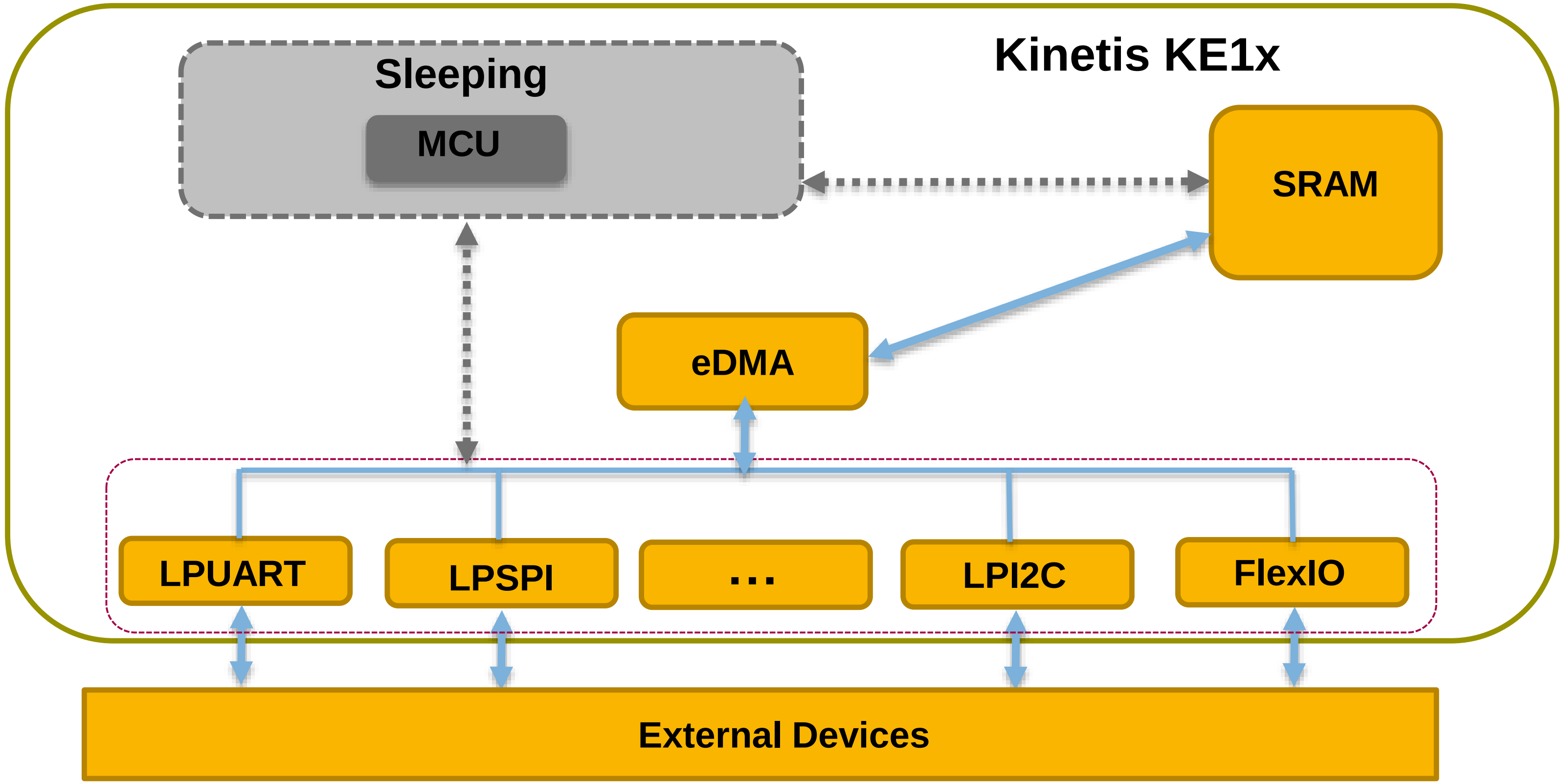
Power Efficiency 高能效

Feature	Benefit to customer
多种功耗模式	Include HSRUN[1], RUN, WAIT, STOP, VLPR, VLPW, VLPS to save power Improve system power efficiency
智能外设	Support working in low power modes Avoid frequently waking CPU and reduce power (TSI[2], LPUART, LPSPI, LPI2C, FlexIO, ADC, eDMA)

1: KE1xF only
2. KE15Z only

高能效 – 智能外设

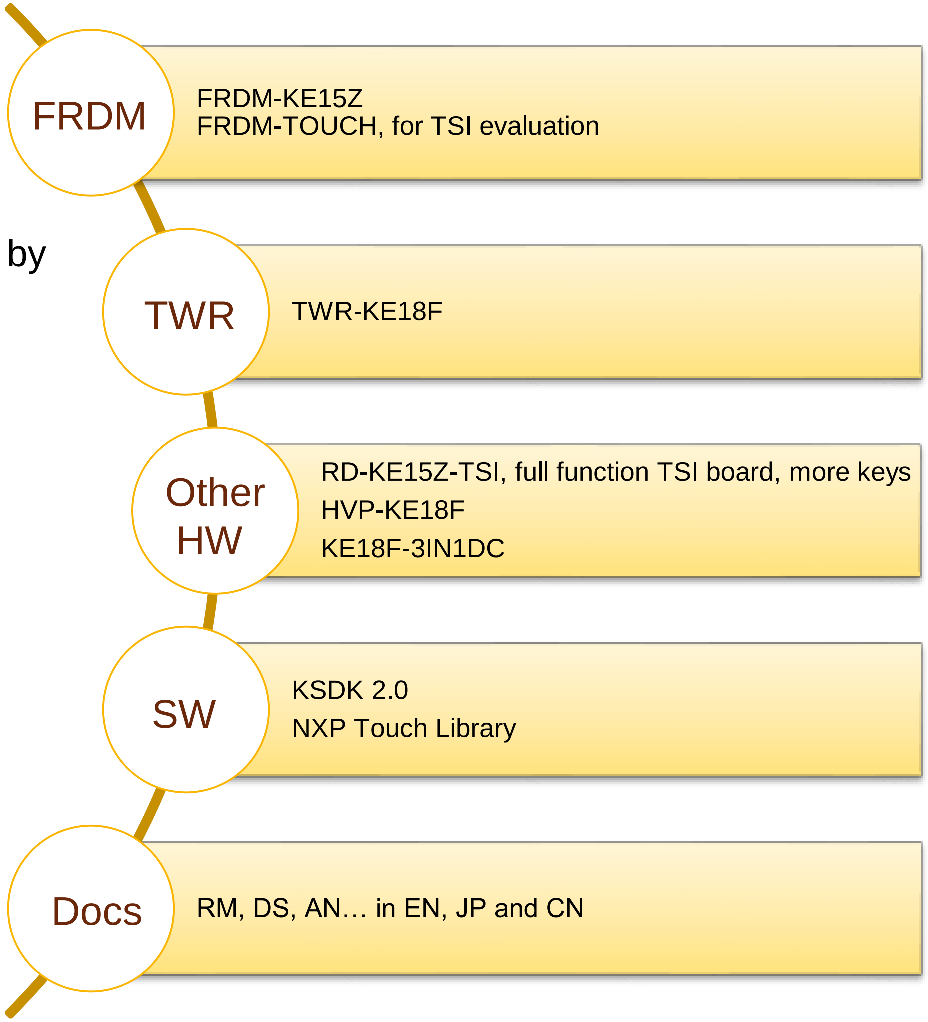
- LPUART, LPSPI, LPI2C, FlexIO 都能在wait及stop模式下工作，并使用eDMA完成数据收发，无需唤醒CPU。



ENABLEMENT

KE1x开发工具

- 软件工具
  - KDS, IAR, KEIL
  - KSDK Kinetis Software Development Kit
  - IEC60730 compliant library (Class B Safety S/W routines certified by VDE)
- 硬件评估平台
  - FRDM
  - TWR
- 参考设计/评估板
  - 3-in-1 motor control, dual motor control and PFC
  - High voltage motor control daughter board
  - Touch sensing in pad, slider and wheel



FRDM

FRDM-KE15Z
FRDM-TOUCH, for TSI evaluation

TWR

TWR-KE18F

Other HW

RD-KE15Z-TSI, full function TSI board, more keys
HVP-KE18F
KE18F-3IN1DC

SW

KSDK 2.0
NXP Touch Library

Docs

RM, DS, AN… in EN, JP and CN

KE1x Enablement – 已有的硬件开发平台

Freedom Platform

FRDM-KE15Z

- Ultra low -cost/power development platform
- Form factor compatible with Arduino platform
- Compatible with Freedom shield

Freedom Shield

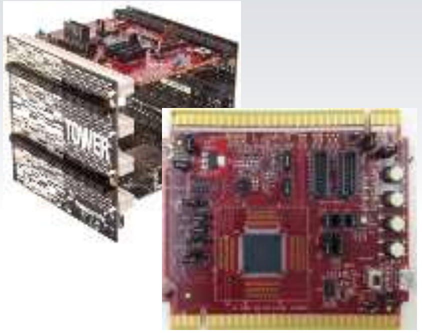
FRDM-TOUCH

- This evaluation board, in a shield form factor, effectively turns a NXP Freedom development board platform into a complete motor control reference design

Tower System

TWR-KE18F

- Richer feature set
- Standard Tower Controller Module
- Compatible with existing Tower System peripherals



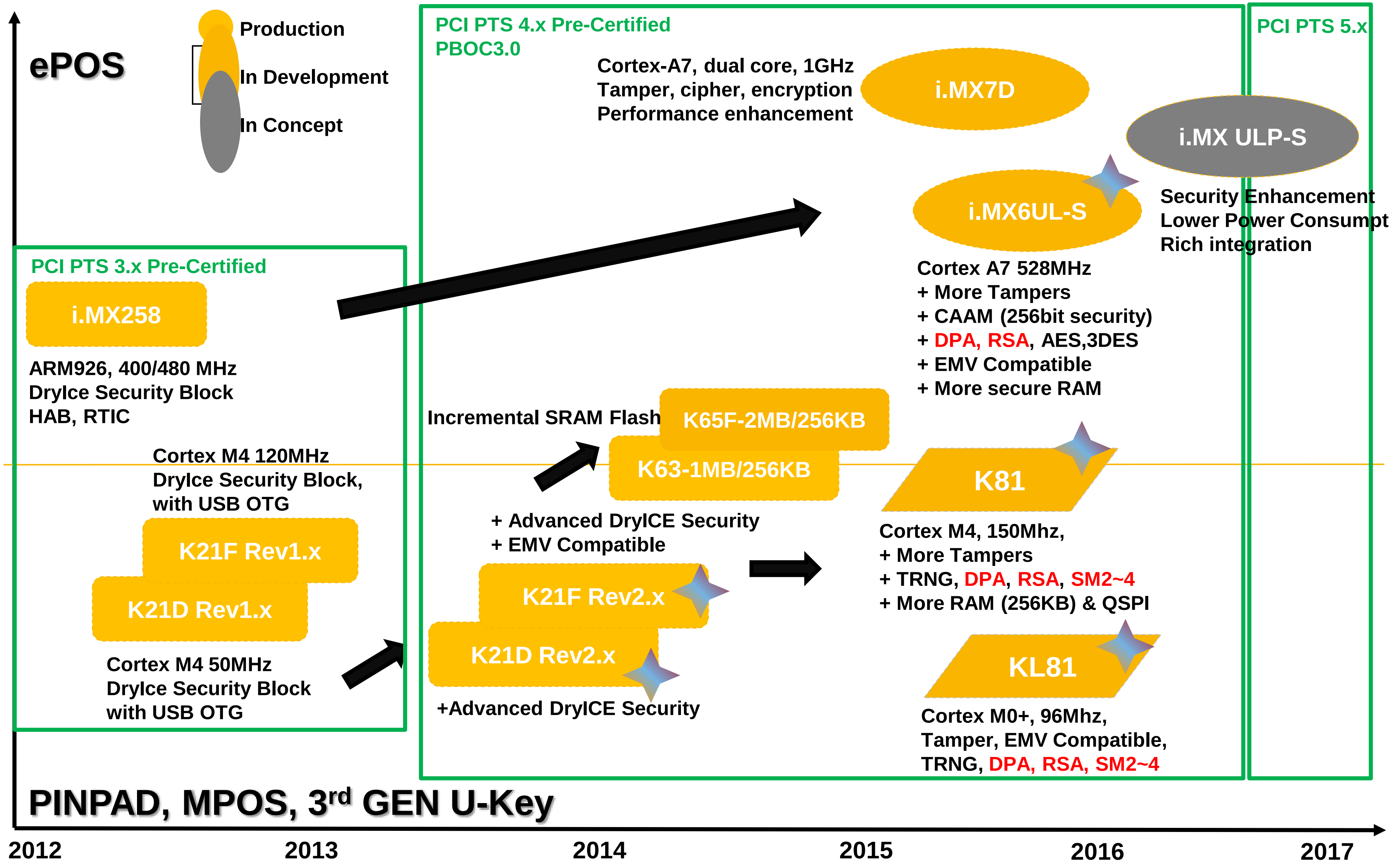
TSI Evaluation Board

RD-KE15Z-TSI

- Evaluation board for new TSI hardware and software design

面向高安全应用场合的 K8X & KL8X

安全类MCU及面向的金融产品应用



ePOS

● Production

● In Development

● In Concept

PCI PTS 3.x Pre-Certified

i.MX258

ARM926, 400/480 MHz
DryIce Security Block
HAB, RTIC

Cortex M4 120MHz
DryIce Security Block,
with USB OTG

K21F Rev1.x

K21D Rev1.x

Cortex M4 50MHz
DryIce Security Block
with USB OTG

PCI PTS 4.x Pre-Certified
PBOC3.0

Cortex-A7, dual core, 1GHz
Tamper, cipher, encryption
Performance enhancement

i.MX7D

i.MX6UL-S

Cortex A7 528MHz
+ More Tampers
+ CAAM (256bit security)
+ DPA, RSA, AES,3DES
+ EMV Compatible
+ More secure RAM

Incremental SRAM Flash

K65F-2MB/256KB

K63-1MB/256KB

+ Advanced DryICE Security
+ EMV Compatible

K21F Rev2.x

K21D Rev2.x

+Advanced DryICE Security

K81

Cortex M4, 150Mhz,
+ More Tampers
+ TRNG, DPA, RSA, SM2~4
+ More RAM (256KB) & QSPI

KL81

Cortex M0+, 96Mhz,
Tamper, EMV Compatible,
TRNG, DPA, RSA, SM2~4

PCI PTS 5.x

i.MX ULP-S

Security Enhancement
Lower Power Consumption
Rich integration

PINPAD, MPOS, 3rd GEN U-Key

K81 Devices (256KB Flash, 256KB SRAM)

Key Features:

Core/System

- Cortex-M4 with 8KB I/D-Cache
- FPU and MPU , BME

Memory

- up to 256KB Flash,
- up to 256KB SRAM
- QSPI Flash interface with OTF

Security

- **True Random Number Generator**
- Crypto acceleration MMCAU
- **160B(32B+128B) Secure RAM for Key storage**
- **Enc. Engine (DES/3DES/AES/RSA)**
  - RSA2048 support (3 decrypt and 1 encrypt <750ms)
  - ECC: ECDSA and ECDH for up to P256
  - DES/3DES with HW DPA
  - AES256/192/128 with DPA
- Up to **8** Tamper Pins
- RDC: Resource Domain Controller

Timers

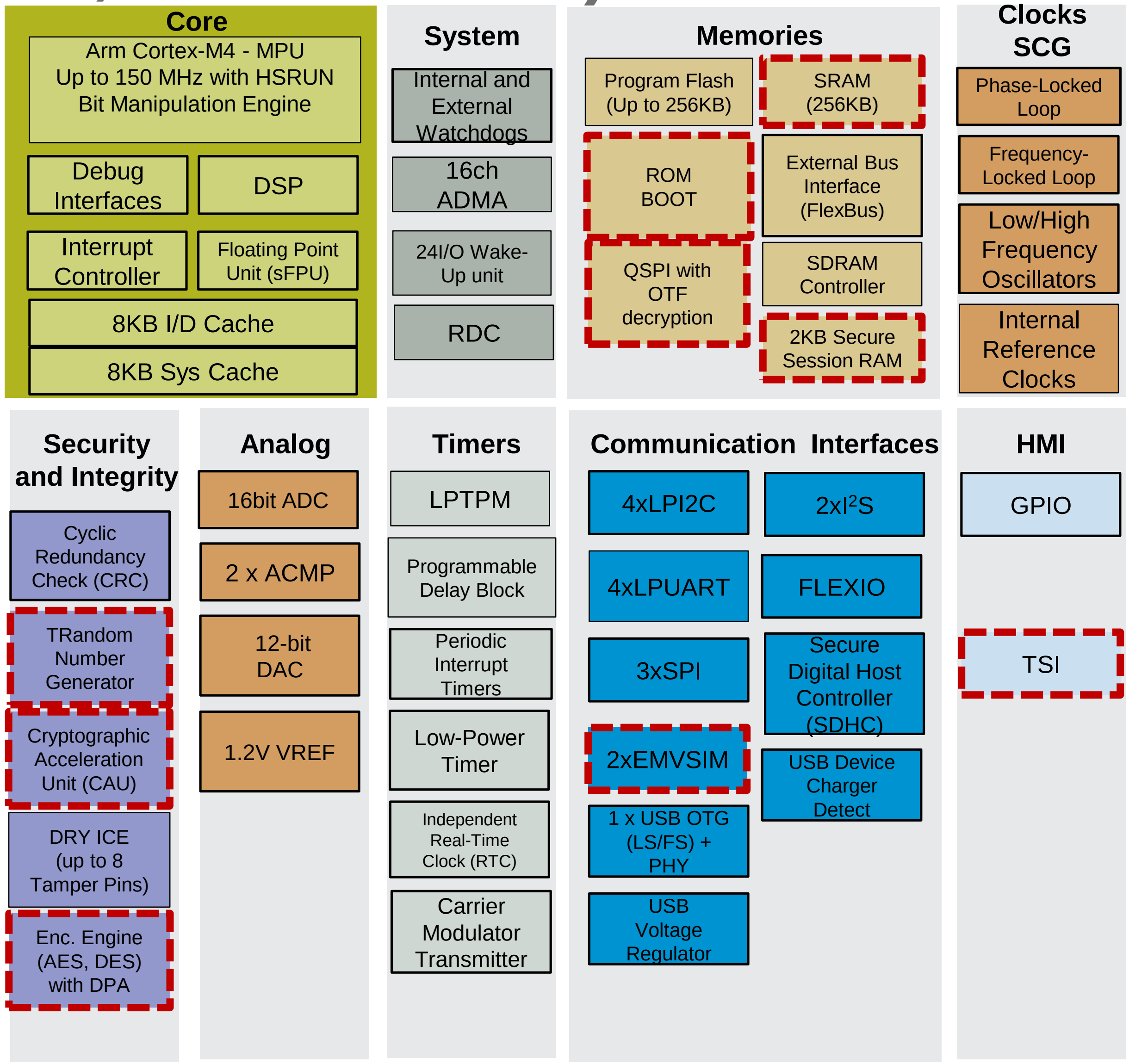
- Independent Real-Time Clock (RTC)

Others

- **2x EMV compatible ISO7816-3 interfaces**
- 1.71V-3.6V; -40 to 105^{o}C
- Up to TBD x I/Os (3V)
- Priority Packages:121MBGA, 100LQFP

Availability

- Samples: Q4 2014
- Qual/Production: Q1 2015



Core

Arm Cortex-M4 - MPU
Up to 150 MHz with HSRUN
Bit Manipulation Engine

Debug Interfaces

DSP

Interrupt Controller

Floating Point Unit (sFPU)

8KB I/D Cache

8KB Sys Cache

System

Internal and External Watchdogs

16ch ADMA

24I/O Wake-Up unit

RDC

Memories

Program Flash (Up to 256KB)

SRAM (256KB)

ROM BOOT

External Bus Interface (FlexBus)

QSPI with OTF decryption

SDRAM Controller

2KB Secure Session RAM

Clocks SCG

Phase-Locked Loop

Frequency-Locked Loop

Low/High Frequency Oscillators

Internal Reference Clocks

Security and Integrity

Cyclic Redundancy Check (CRC)

TRandom Number Generator

Cryptographic Acceleration Unit (CAU)

DRY ICE (up to 8 Tamper Pins)

Enc. Engine (AES, DES) with DPA

Analog

16bit ADC

2 x ACMP

12-bit DAC

1.2V VREF

Timers

LPTPM

Programmable Delay Block

Periodic Interrupt Timers

Low-Power Timer

Independent Real-Time Clock (RTC)

Carrier Modulator Transmitter

Communication Interfaces

4xLPI2C

2xI^{2}S

4xLPUART

FLEXIO

3xSPI

Secure Digital Host Controller (SDHC)

2xEMVSIM

USB Device Charger Detect

1 x USB OTG (LS/FS) + PHY

USB Voltage Regulator

HMI

GPIO

TSI

KL81 Devices (128KB Flash, 96KB SRAM)

Key Features:

Core/System

- Cortex-M0+
- MTB
- BME

Memory

- up to 128KB Flash,
- up to 96KB SRAM
- QSPI Flash interface

Security

- **True Random Number Generator**
- Crypto acceleration MMCAU
- **160B(32B+128B) Secure RAM for Key storage**
- **Enc. Engine (DES/3DES/AES/RSA)**
  - RSA2048 support (3 decrypt and 1 encrypt <750ms)
  - ECC: ECDSA and ECDH for up to P256
  - DES/3DES with HW DPA
  - AES256/192/128 with DPA
- Up to 8 Tamper Pins
- RDC: Resource Domain Controller

Timers

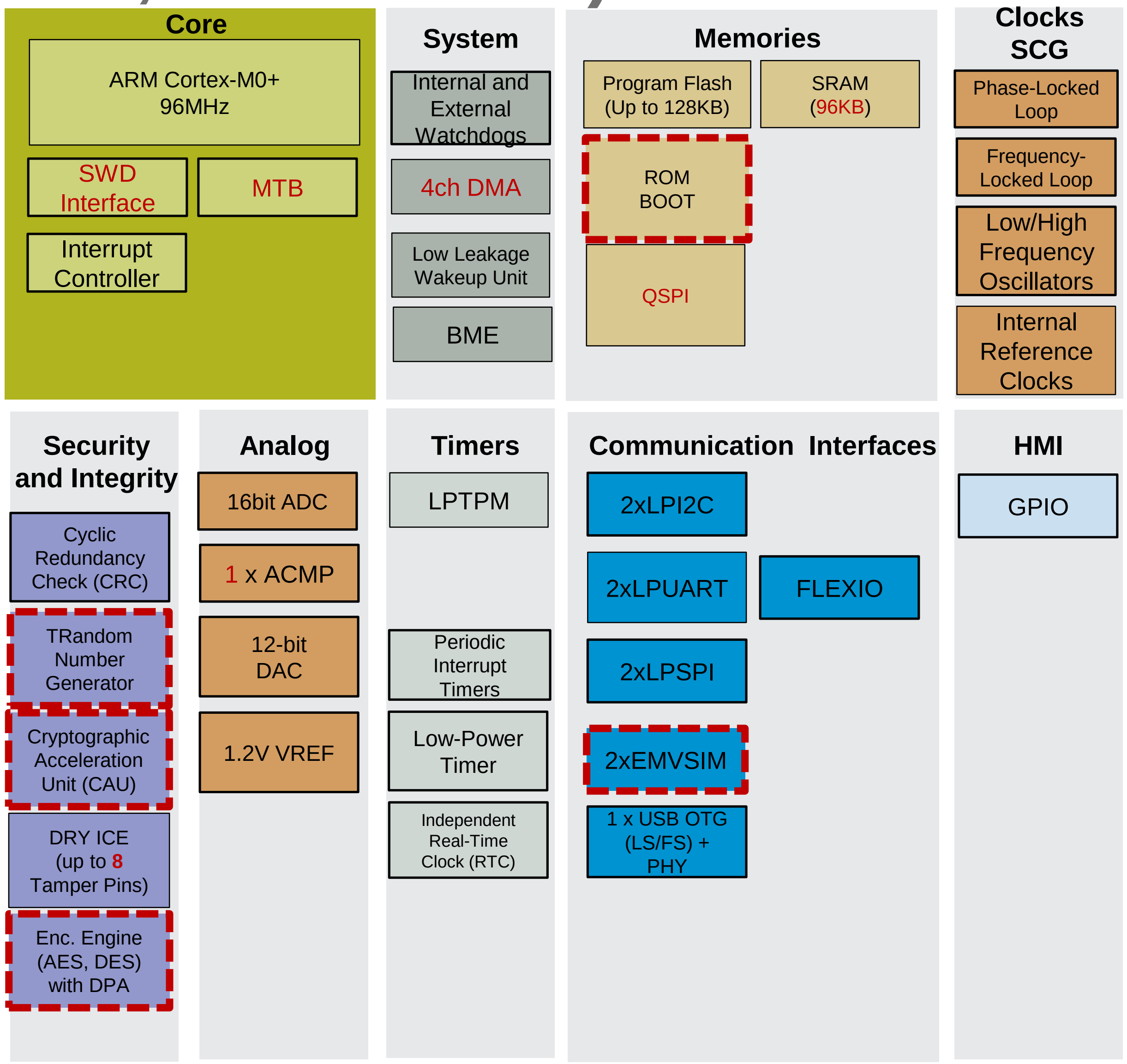
- Independent Real-Time Clock (RTC)

Others

- **2x EMV compatible ISO7816-3 interfaces**
- 1.71V-3.6V; -40 to 105ºC
- Up to TBD x I/Os (3V)
- Priority Packages:121MAPBGA, 80LQFP, 64LQFP

Availability

- Samples: Q1 2015
- Qual/Production: Q2 2015



Core
ARM Cortex-M0+ 96MHz
SWD Interface
MTB
Interrupt Controller

System
Internal and External Watchdogs
4ch DMA
Low Leakage Wakeup Unit
BME

Memories
Program Flash (Up to 128KB)
SRAM (96KB)
ROM BOOT
QSPI

Clocks SCG
Phase-Locked Loop
Frequency-Locked Loop
Low/High Frequency Oscillators
Internal Reference Clocks

Security and Integrity
Cyclic Redundancy Check (CRC)
TRandom Number Generator
Cryptographic Acceleration Unit (CAU)
DRY ICE (up to 8 Tamper Pins)
Enc. Engine (AES, DES) with DPA

Analog
16bit ADC
1 x ACMP
12-bit DAC
1.2V VREF

Timers
LPTPM
Periodic Interrupt Timers
Low-Power Timer
Independent Real-Time Clock (RTC)

Communication Interfaces
2xLPI2C
2xLPUART
FLEXIO
2xLPSPI
2xEMVSIM
1 x USB OTG (LS/FS) + PHY

HMI
GPIO

日程

Kinetis K81的介绍

- Oveview & Architecture
- Flash Security for Code Protection and Trust Boot
- DryICE for Tamper Detection
- QSPI
- LP Trusted Cryptography (LTC)
- TRNG
- EMVSIM
- SDK

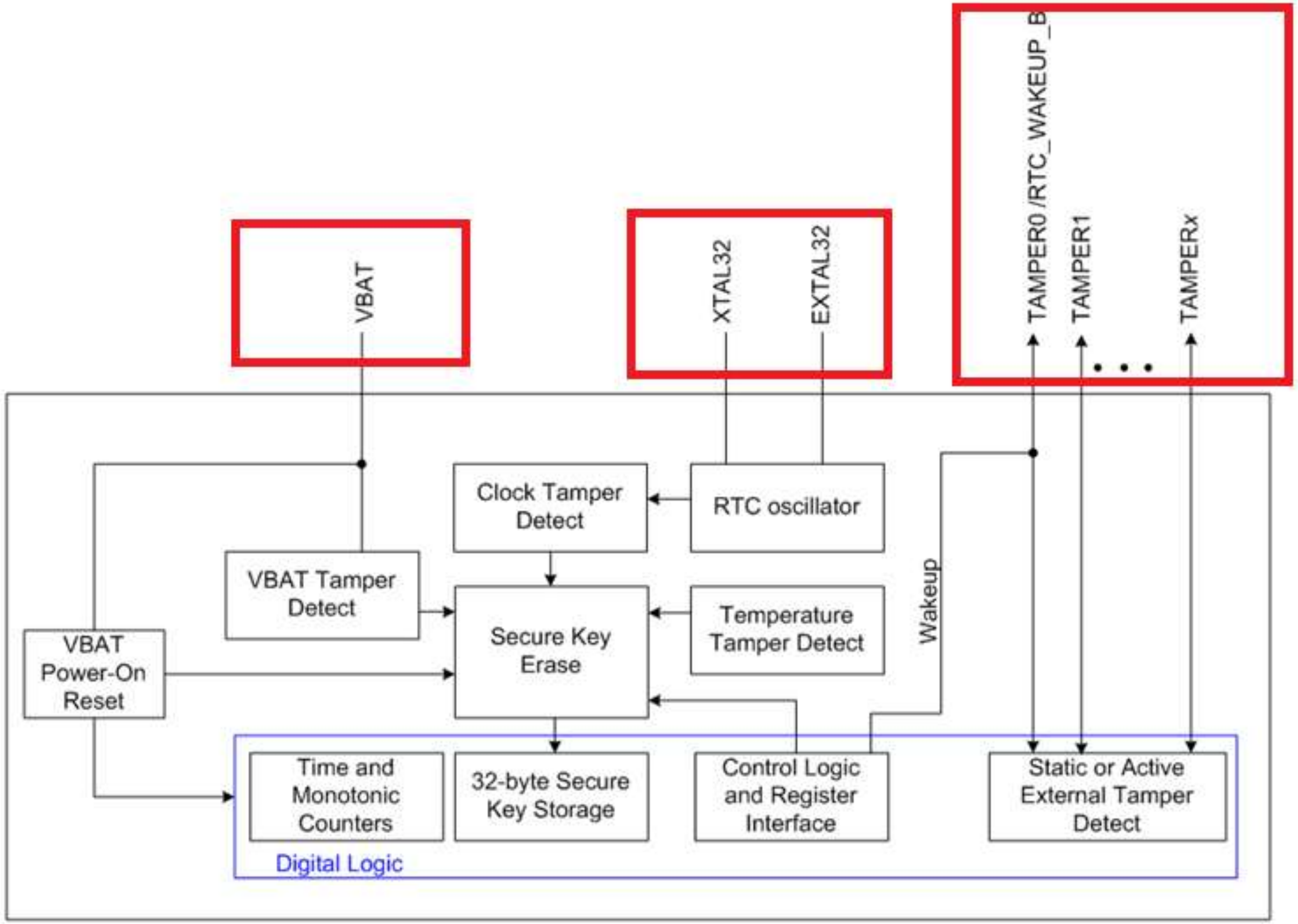
OVERVIEW & ARCHITECTURE

K81 关键特性

- 高性能的150 MHz ARM® Cortex®-M4F MCU with 8KB I/D-Cache
- 最大256 KB program flash 及 256 KB SRAM
- FlexBus 扩展总线接口及SDRAM 控制器接口
- Dual QuadSPI接口， 支持 XIP(eXecute In Place)， 对于加密image支持OTF decryption
- Digital Host Controller (SDHC) 和FlexIO
- 低功耗的电容式触摸感应接口
- 2x EMVSIM 模块，符合EMV Standard v4.3 及ISO 7816-3 接口标准
- 外部侵入侦测 管脚, 2KB 安全SRAM存储用于存放秘钥
- LP Trusted Crypto (LTC) 硬件加速器能够同时执行AES, DES, 3DES, RSA and ECC等运算
- 真随机数发生器
- 同时也支持CAU模块的DES, AES, SHA的硬件加速

用于侵入侦测的
DRYICE模块

DryIce/安全的RTC



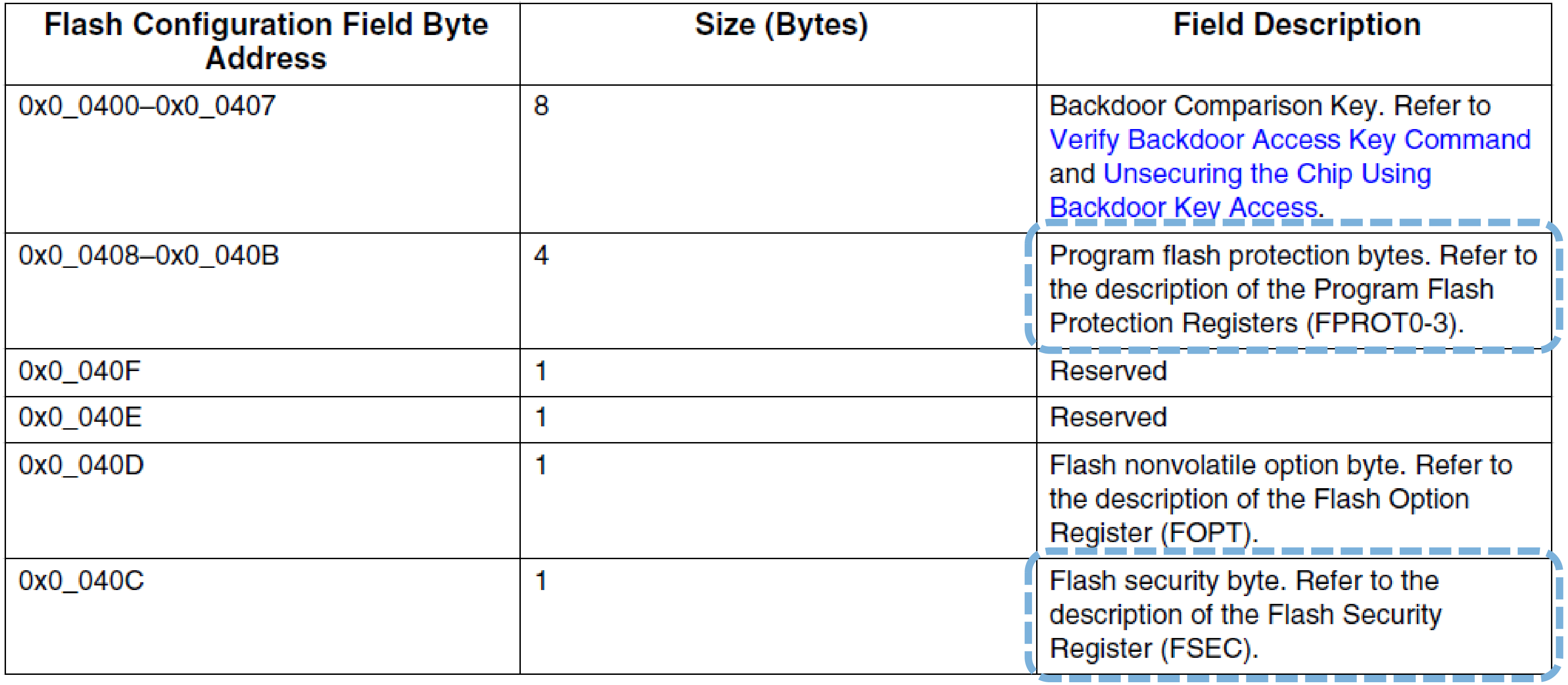
DryICE 特性

- 独立的VBAT供电系统，32.768kHz的专供时钟源，即使在MCU断电的情况下，保持DryIce模块的正常工作
- 多达8个外部的侵害侦测I/O， 同样工作在VBAT供电域，并能够工作于静态或者主动模式
- 这些防侵入I/O能够配置触发的极性及输入滤波
- 用户可以通过配置两个动态侵入移位寄存器，生成16bit的多项式函数，用于在tamper I/O工作于主动模式时的输入输出校验
- 安全存储区域将在侦测到侵入时被擦除.
- 被保护的寄存器能够在VBAT电源域重新上电的过程中被重新使能读写的权限
- 侵入时间寄存器将记录下受到侵入的时间.
- 多种侵入事件， 包括温度， 电压，时钟等可以单独配置

FLASH访问安全保护及安全启动

Flash配置域

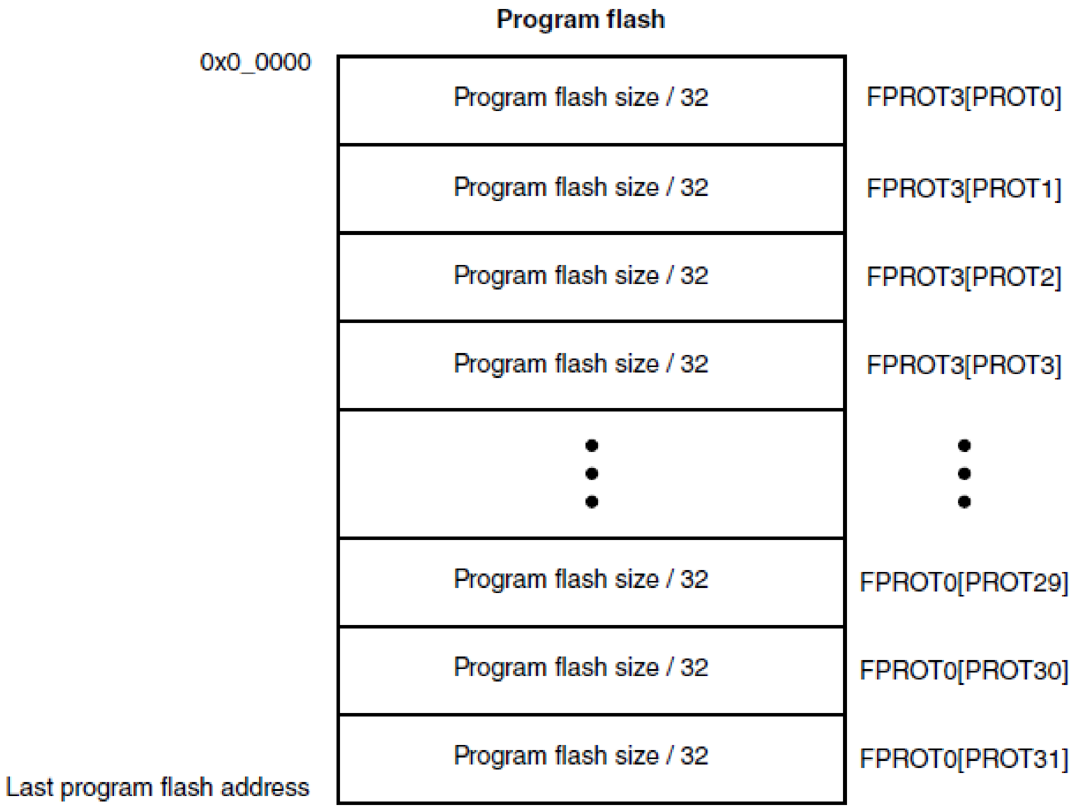
- 在flash区域的0x400-0x40F区域，包含了16个字节的flash配置字节，这些配置项包括了对flash安全配置的选项。



Flash Configuration Field Byte Address	Size (Bytes)	Field Description
0x0_0400–0x0_0407	8	Backdoor Comparison Key. Refer to Verify Backdoor Access Key Command and Unsecuring the Chip Using Backdoor Key Access.
0x0_0408–0x0_040B	4	Program flash protection bytes. Refer to the description of the Program Flash Protection Registers (FPROT0-3).
0x0_040F	1	Reserved
0x0_040E	1	Reserved
0x0_040D	1	Flash nonvolatile option byte. Refer to the description of the Flash Option Register (FOPT).
0x0_040C	1	Flash security byte. Refer to the description of the Flash Security Register (FSEC).

Flash保护寄存器

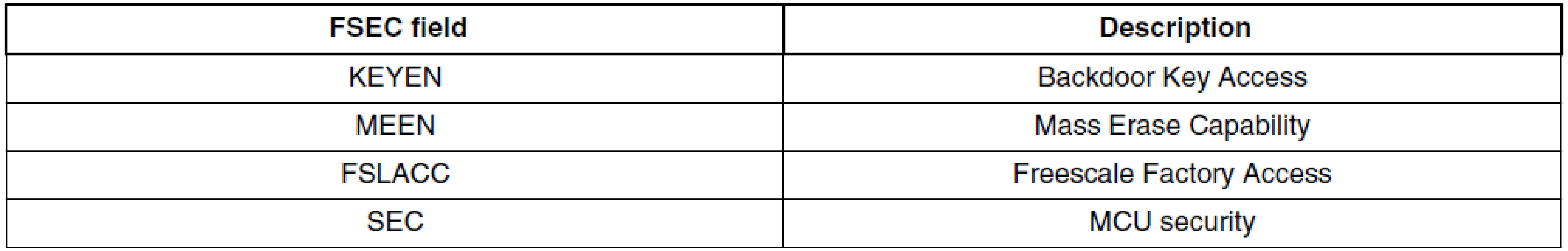
- FPROT寄存器定义了受保护的flash区域，受保护的区域将不能被编程及擦除
- FPROT可以将所有flash分成32等分，受保护的区域最小单位即这样一个等分



Program flash

0x0_0000	Program flash size / 32	FPROT3[PROT0]
	Program flash size / 32	FPROT3[PROT1]
	Program flash size / 32	FPROT3[PROT2]
	Program flash size / 32	FPROT3[PROT3]
	⋮	⋮
	Program flash size / 32	FPROT0[PROT29]
	Program flash size / 32	FPROT0[PROT30]
Last program flash address	Program flash size / 32	FPROT0[PROT31]

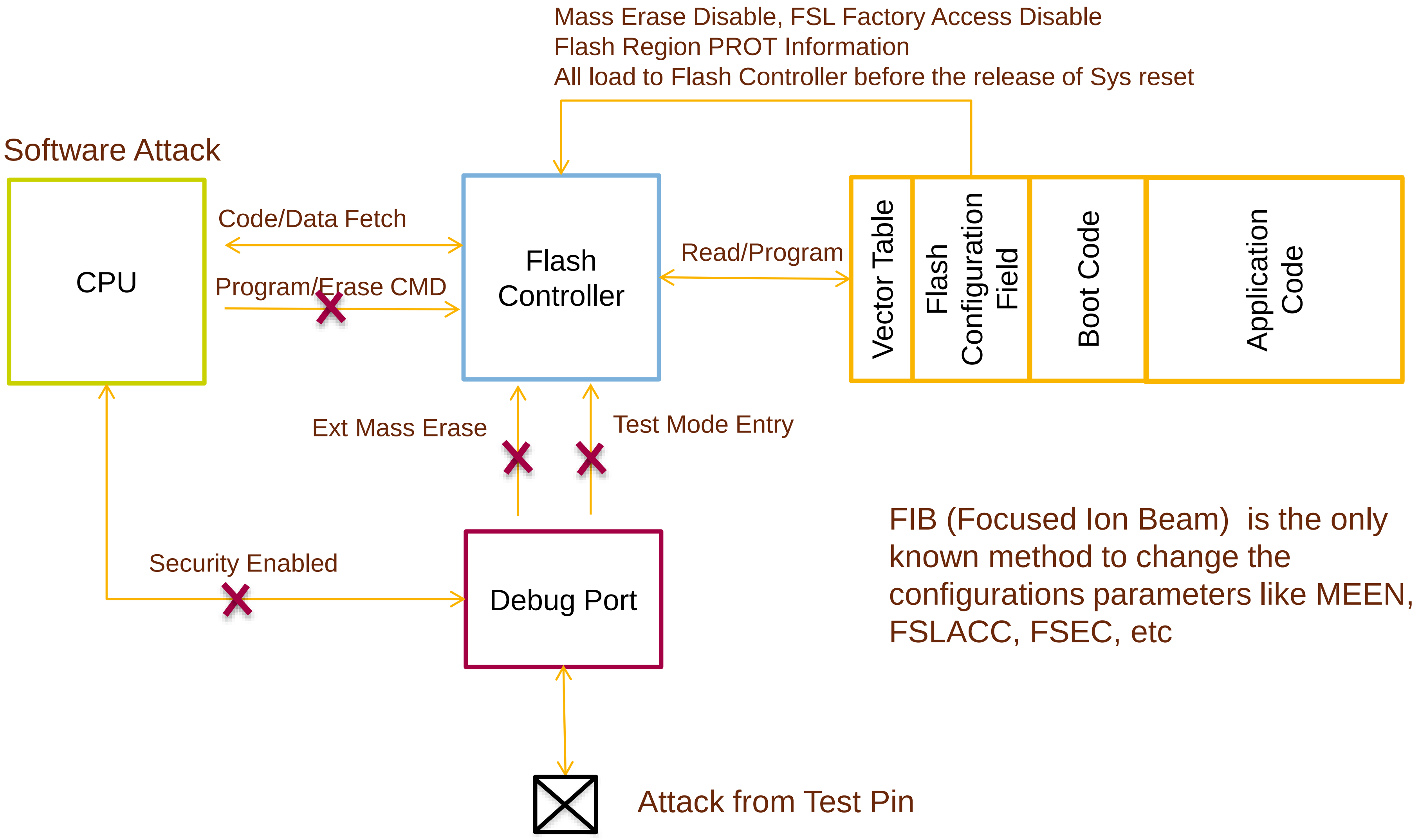
Flash 安全寄存器



FSEC field	Description
KEYEN	Backdoor Key Access
MEEN	Mass Erase Capability
FSLACC	Freescale Factory Access
SEC	MCU security

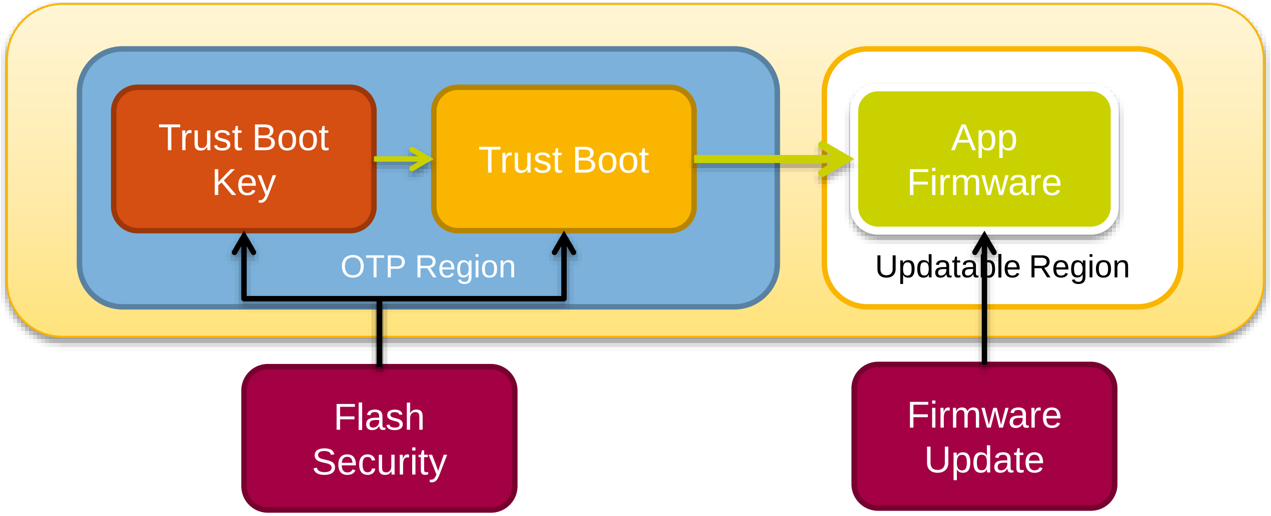
- 如果禁用Mass Erase，任何擦除OTP区域及flash配置域的企图都会失败
- 如果禁用“工厂访问”功能，任何进入测试模式及特殊模式的企图都会失败
- SEC位定义了MCU的安全状态，如果MCU被定义为安全状态，通过Debug口去访问内存区域是不被允许的

安全访问的整体框架



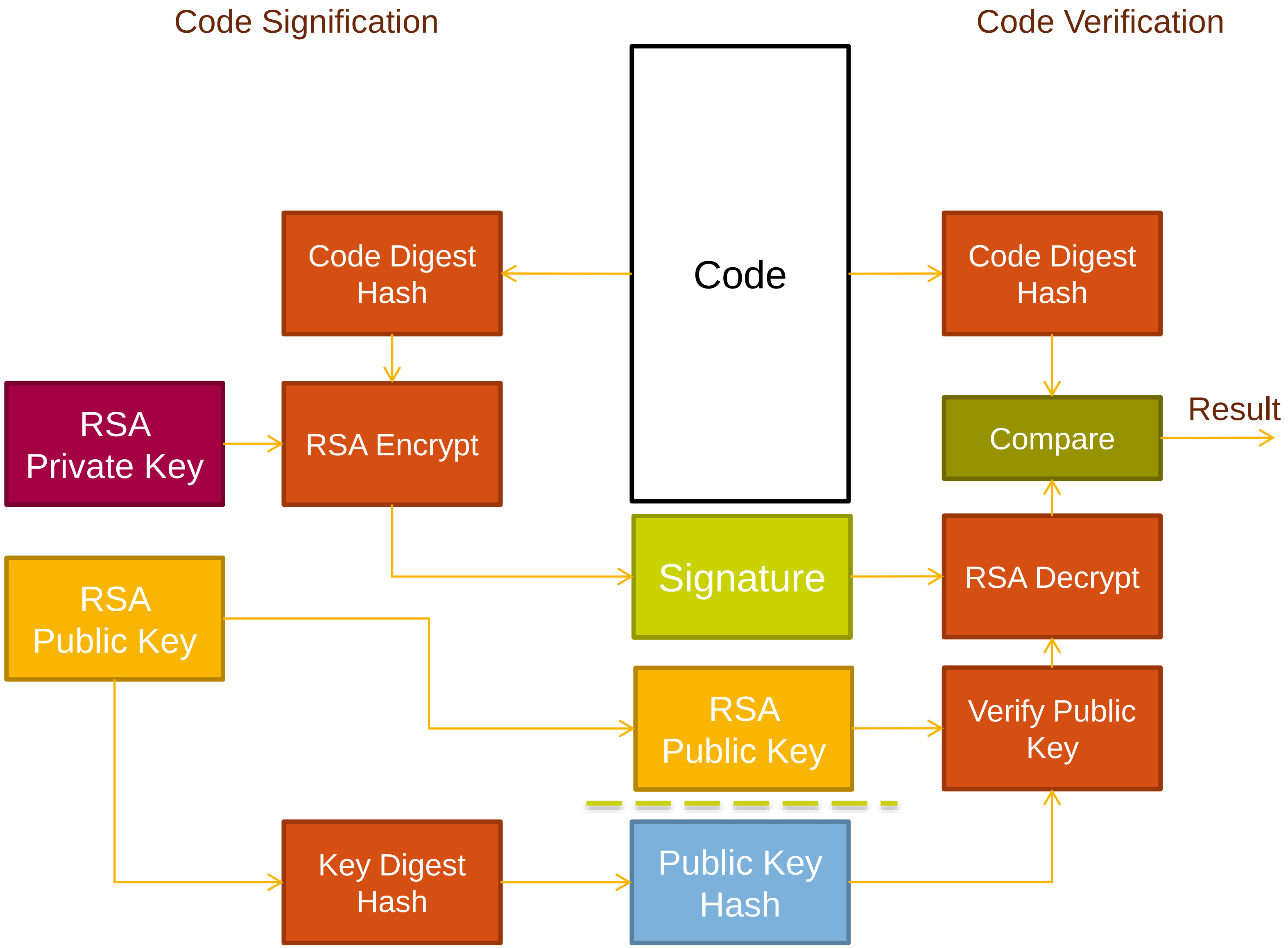
FIB (Focused Ion Beam) is the only known method to change the configurations parameters like MEEN, FSLACC, FSEC, etc

加密代码的安全启动



- 授信启动区域（Trust Boot region）用于鉴别应用代码
- 安全的bootloader在跳转到应用代码之前，会验证基于PKSC(e.g. RSA2048) 的数字签名
- 授信启动区域的代码及公钥被编程进OTP区间，是不可能被修改的
- 应用代码是能够被随时更新的

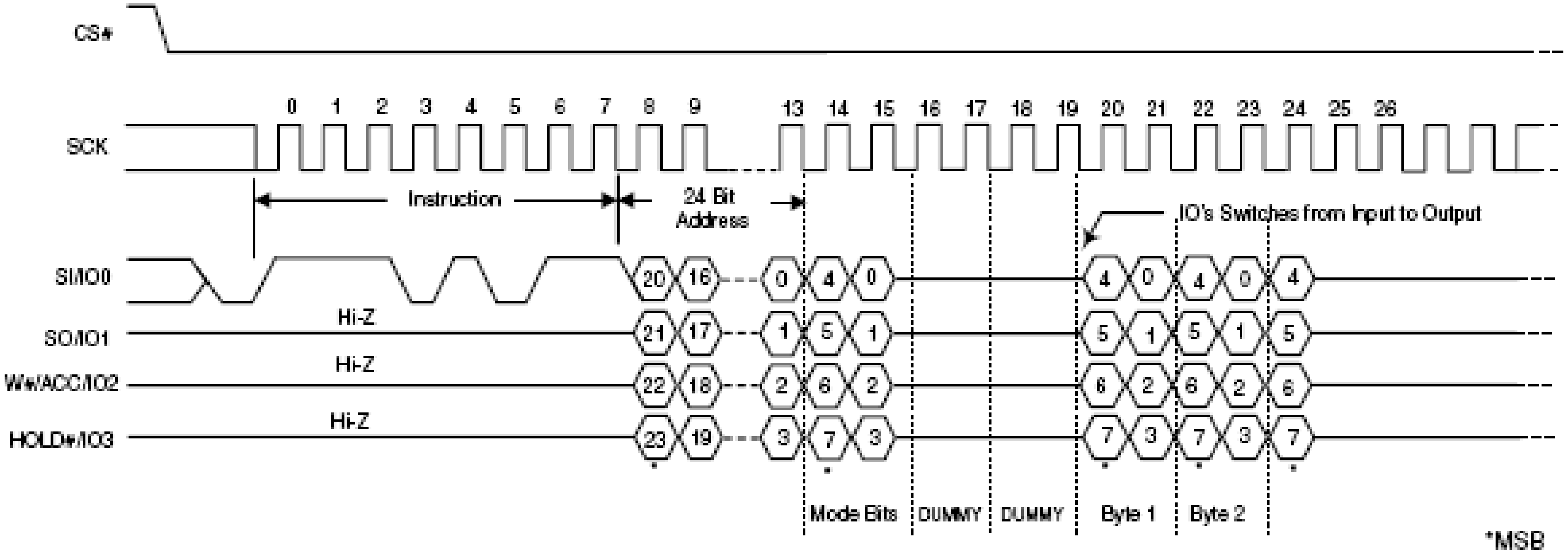
K80授信启动的全流程



QUADSPI

QuadSPI Flash

- 用于接口外部的串行Flash
- 通信接口类似于SPI
- 具有可编程命令时序引擎，能够支持XIP，片上执行代码
- 支持On-The-Fly-Decryption-Engine (OTFAD)
- 支持单，双，4线甚至8线的数据线接口，并能工作于SDR或者DDR模式
- SDR模式最大可以工作于100MHz，DDR最高可以工作于75MHz
- 支持24-bit及32-bit地址寻址



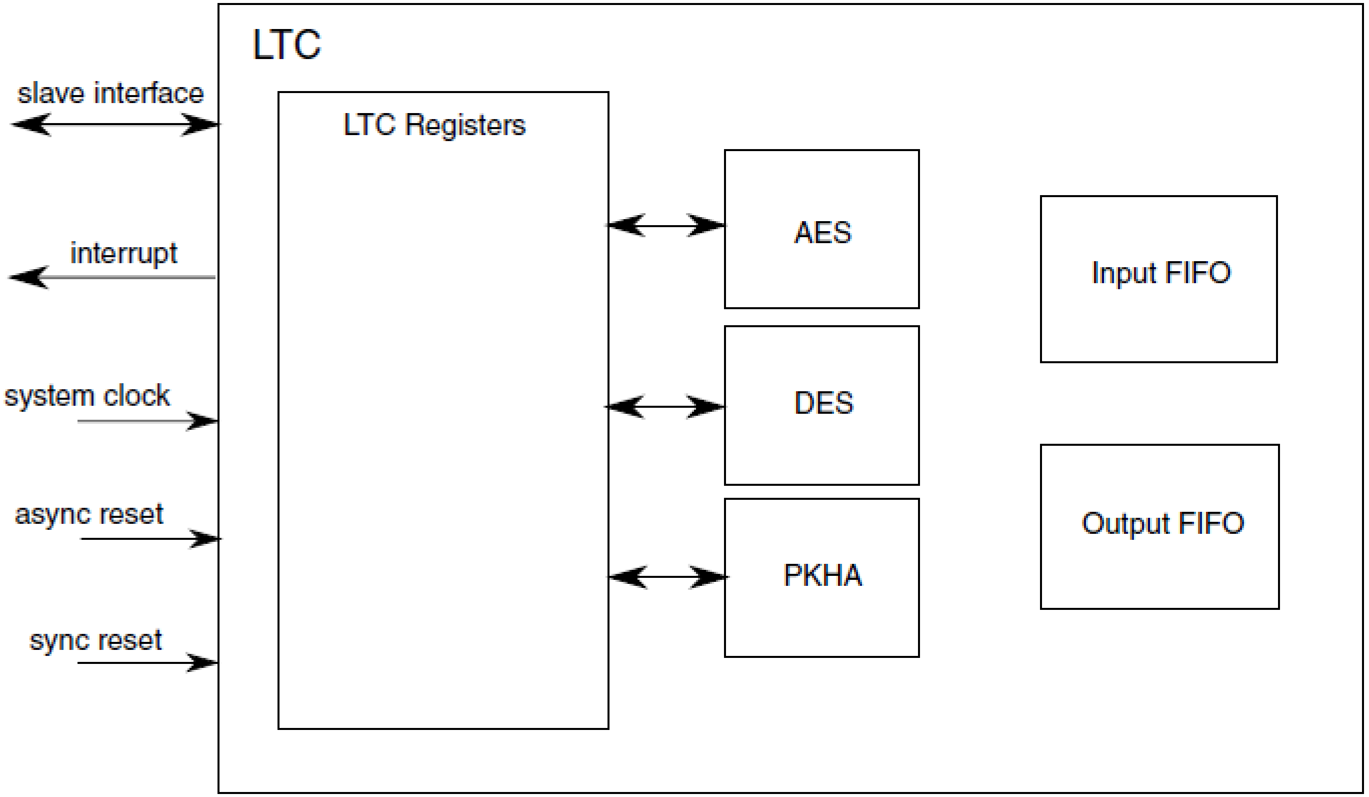
On-the-Fly AES Decryption Module (OTFAD) 运行时AES解密模块

- 使用AES-128秘钥保护存储在外部存储中的应用代码,并在代码执行时使用OTFAD解密
- AES-128 Counter Mode On-the-Fly Decryption
  - 128-bit key and 128-bit data block sizes
  - Adds zero cycles of incremental latency for decryption when used with QuadSPI
  - Receives 64-bit encrypted data from QuadSPI, calculates decrypted data which is sent to AHB RAM buffer and bypassed back to system AHB read data bus
- Hardware support for 4 independent decryption segments, known as memory “contexts”
  - Each context has a unique 128-bit key, 64-bit counter and 64-bit memory region descriptor
- Functionally acts as a slave sub-module to the QuadSPI
  - Logically connected "between" the QuadSPI and its AHB RAM buffer
  - Shares system AHB and IPS (slave peripheral) bus connections
  - Private 64-bit data buses for encrypted (ciphertext) and decrypted (plaintext) data

LP TRUSTED CRYPTOGRAPHY (LTC)

LP Trusted Cryptography (LTC)

- 允许多个硬件加密引擎实例化
- **目前支持** AES, DES, 3DES, RSA and ECC(KL81 加入了SHA)



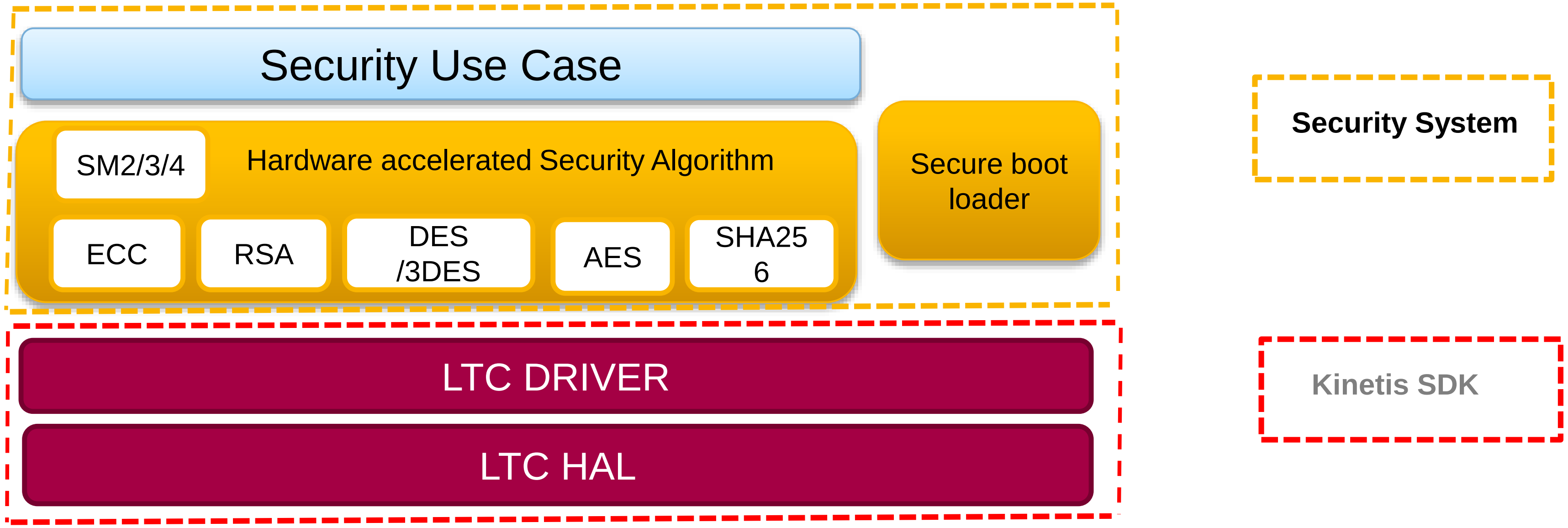
对称加密

- AES with HW DPA
  - Electronic codebook (ECB)
  - Cipher block chaining (CBC)
  - Output feedback (OFB)
  - 128-bit cipher feedback (CFB128)
  - Counter (CTR)
  - Extended cipher block chaining message authentication code (XCBC-MAC)
  - Cipher-based MAC (CMAC)
  - CTR and CBC-MAC (CCM)
  - Galois/Counter mode (GCM)
  - Combined CBC and CMAC (CBC-CMAC)
  - Combined CTR and CMAC (CTR-CMAC)
- DES (KL81 support HW DPA)
  - Supports both single- and triple-DES functionality
  - ECB, CBC, CFB, and OFB modes

公钥加密

- Public-key hardware accelerator (PKHA) perform a number of different operations used in public-key cryptography
  - Integer MOD arithmetic
    - Addition
    - Subtraction
    - Multiplication
    - Exponentiation
    - Reduction
    - Inversion
  - Elliptic-Curve Mathematics
    - Point math over a prime field (Fp)
    - Point math over a binary field (F2m)
  - RSA up to 2048-bit
  - ECC up to 512-bit

K81/KL81基于SDK的安全类demo



- Implemented key security algorithm based on LTC
- Security use case
  - ✓ Data Encryption/Decryption
  - ✓ Hash function
  - ✓ Digital signature
  - ✓ Key exchange
  - ✓ Message authentication
- Secure boot loader with image authentication and upgrade
- Closed the gap between customer’s requirement and LTC driver

TRNG

True Random Number Generator

- **使用硬件加速生成512-bit的**熵
- 熵来源于随机噪声
- **随机噪声源来源于一个**环形振荡器，该振荡器对随机噪声相当敏感，包括温度、电压、串扰等随机噪声
- **随机数很**难被猜测及预测

EMVSIM

Euro/Mastercard/Visa/SIM Serial Interface Module(EMVSIM)

- 支持智能卡标准EMV Standard v4.3 及ISO 7816-3接口
- SIM的时钟（包括收和发）是独立的，相应的寄存器的读写时钟也是独立的
- 当发生奇偶校验错误或者接收缓冲区溢出时自动产生NACK信号
- 具有自动重传机制
- 接收时自动检测NACK
- 具有独立的可调节定时器用于计算“character wait time, block wait time and block guard time”
- 可选择时钟源的计数器
- 支持DMA传输

EMV 认证方案

- K81(TWR-K81&POSCard board) 通过了EMV L1 pre-certification
- 提供EMV L1 stack lib and EMVSIM driver
- 标准的EMV L1认证设备 (Micropross Star3150)

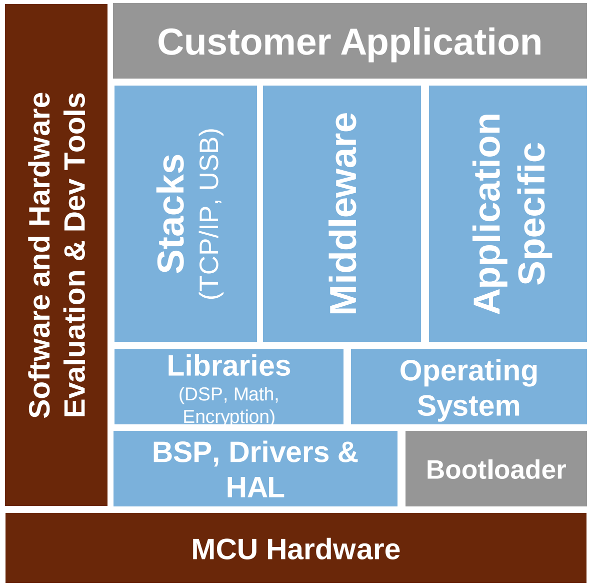
SDK

Learn more at: www.freescale.com/KSDK

Kinetis Software Development Kit (SDK)

A complete software framework for developing applications across all Kinetis MCUs

HAL, peripheral drivers, libraries, middleware, utilities, and usage examples; delivered in C source



Software and Hardware Evaluation & Dev Tools

Customer Application

Stacks (TCP/IP, USB)

Middleware

Application Specific

Libraries (DSP, Math, Encryption)

Operating System

BSP, Drivers & HAL

Bootloader

MCU Hardware

Product Features

- Open source Hardware Abstraction Layer (HAL) provides APIs for all Kinetis hardware resources
- BSD-licensed set of peripheral drivers with easy-to-use C-language APIs
- Comprehensive HAL and driver usage examples and sample applications for RTOS and bare-metal.
- CMSIS-CORE compatible startup and drivers plus CMSIS-DSP library and examples
- RTOS Abstraction Layer (OSA) with support for Freescale MQX, FreeRTOS, Micrium uC/OS, bare-metal and more
- Integrates USB and TCP/IP stacks, touch sensing software, encryption and math/DSP libraries, and more
- Support for multiple toolchains including GNU GCC, IAR, Keil, and Kinetis Design Studio
- Integrated with Processor Expert

The OSI logo trademark is the trademark of Open Source Initiative.

Kinetis IDE Options

✓ SDK 1.2

Featured IDEs:

✓ Atollic TrueSTUDIO

- Professional ECLIPSE/GNU based IDE with a MISRA-C checker, code complexity analysis and source code review features.
- Advanced RTOS-aware debugger with ETM/ETB/SWV/ITM tracing, live variable watch view and fault analyzer. Dual-core and multi-processor debugging.
- Strong support for software engineering, workflow management, team collaboration and improved software quality.

Green Hills MULTI

- Complete & integrated software and hardware environment with advanced multicore debugger
- Industry first TimeMachine trace debugging & profiler
- EEMBC certified top performing C/C++ compilers

✓ Keil Microcontroller Development Kit

- Specifically designed for microcontroller applications, easy to learn and use, yet powerful enough for the most demanding embedded applications
- ARM C/C++ build toolchain and Execution Profiler and Performance Analyzer enable highly optimized programs
- Complete Code Coverage information about your program's execution

✓ IAR Embedded Workbench

- A powerful and reliable IDE designed for ease of use with outstanding compiler optimizations for size and speed
- The broadest Freescale ARM/Cortex MCU offering with dedicated versions available with functional safety certification
- Support for multi-core, low power debugging, trace, ...

Complimentary Solutions:

✓ Kinetis Design Studio

- Complimentary basic capability integrated development environment (IDE) for Kinetis MCUs
- Eclipse and GCC-based IDE for C/C++ editing, compiling and debugging

mbed Development Platforms

- The fastest way to get started with Kinetis MCUs
- Online project management and build tools – no installation required; option to export to traditional IDEs
- Includes comprehensive set of drivers, stacks and middleware with a large community of developers.

Additional Ecosystem Partners:

EMPROG   iSYSTEM   LAUTERBACH DEVELOPMENT TOOLS

Q&A

SECURE CONNECTIONS
FOR A SMARTER WORLD