



Kinetis V Series Overview: Motor Control and Power Conversion Made Easy with ARM® Cortex®-M-Based Solutions

FTF-IND-F1143

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External Use



Agenda

- Target Markets & Positioning
- MCU Families
- Enablement



Motor Control and Power Conversion Market Trends

Motor Control

Innovation

Precise speed and torque control, quieter operation, increased reliability, connectivity for remote system monitoring

Increased efficiency

Significant reduction in motor power consumption with modern BLDC, PMSM and ACIM technologies

System integration

Reduced component count & BOM cost

Hardware and software reuse

Multiple end-products from a single MCU platform – entry level BLDC, to multi- motor PMSM and ACIM

Safety, reliability and security

Compliance with regional safety standards, extended product life



Power Conversion

Innovation

Dynamic load compensation, system parameter modification to counter analog component drift

Increased conversion efficiency

Reduced power consumption and improved green credentials

Increased power density

Smaller, cooler systems

Software flexibility

Product customization for different customers, applications and regions

Safety, reliability and security

Compliance with regional safety standards, extended product life



Kinetis V Series MCUs based on ARM Cortex Cores

For Motor Control & Digital Power Conversion



- Freescale's **extensive motor and power control expertise** and the latest **ARM Cortex-M0+, M4 and M7 cores** bring secure, connected, high efficiency motor control and power conversion to the mass market
- Efficient, next generation BLDC, PMSM and ACIM designs are enabled by **optimized MCU performance** and **high speed/resolution analog and timing peripherals**. High resolution **eFlexPWMs** support digital power conversion
- Performance and feature scalable MCU families from **entry-level 75MHz MCUs**, to **advanced 240MHz MCUs**, maximize hardware & software reuse and end product flexibility
- Enablement tools including the **Freescale Tower & Freedom development boards**, **Embedded Software Libraries** and **Kinetis motor suite** reduce the motor control learning curve and time to market



Kinetis V Series MCUs: Target Applications

Motor Control

- Sensored BLDC / PMSM
 - High Dynamic Control
- Sensored ACIM
- Sensorless FOC
 - PMSM/BLDC
 - High Dynamic Control
 - Low Dynamic Control
- Sensorless ACIM
- Multi-Motor Control

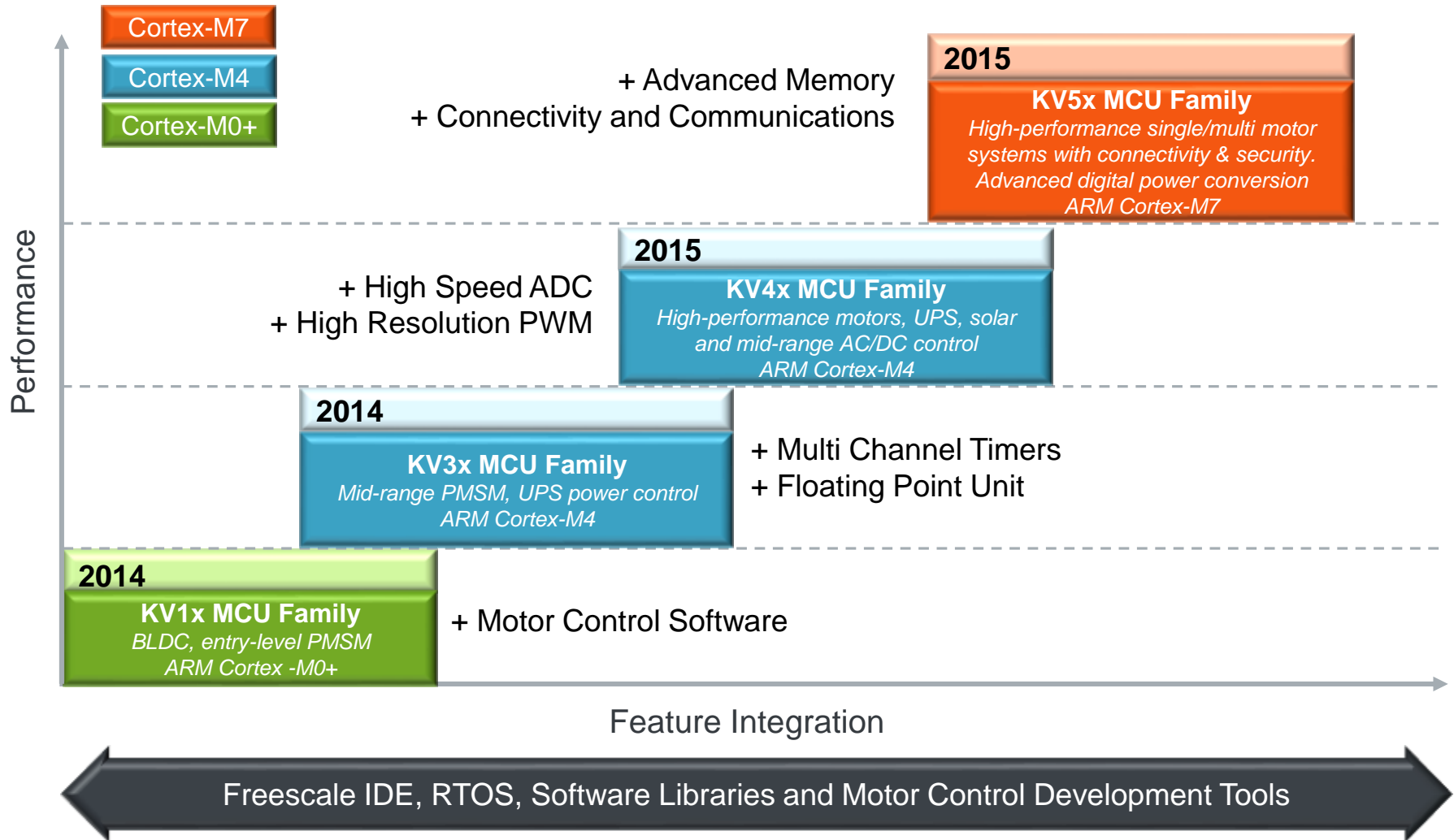


Digital Power Conversion

- Solar Inverters
 - Grid-Tied
 - Non Grid Tied
- Power factor correction
- Switch Mode Power Supplies
 - AC/DC
 - DC/DC
- UPS
 - On-Line
 - Offline
- Inductive cooking
 - Multi cook plate

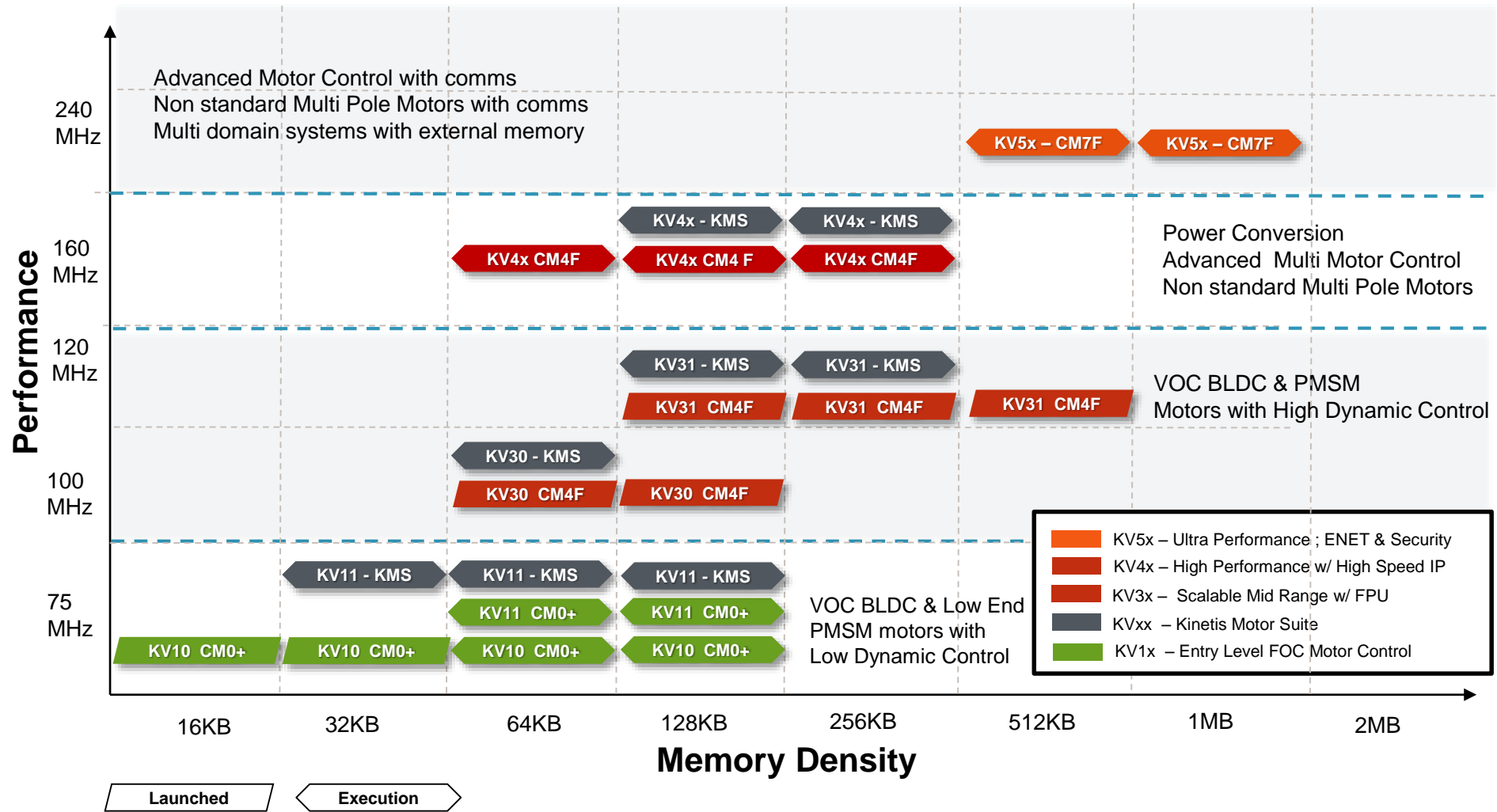


New Levels of Performance, Reliability and Power Efficiency for Motor Control and Digital Power Conversion



Kinetis V Series Product Roadmap

Motor & Power Control specific MCUs, Based on ARM® Cortex-M™ with best-in-class Enablement



Kinetis V Series: Motor Control & Digital Power Peripherals

eFlexPWM: Freescale's most advanced timer module with features such as Half Cycle Reload that ease development and timing to multiple time bases for controlling up to 4 individual control loops

8-ch eFlexPWM

High Resolution PWM: enables better control over harmonics, and reduced sample to delay output. Precise frequency control for power conversion applications

NanoEdge PWM

Quadrature Decoder

Quad Decoder: used for sensing the motor speed for servo applications or position calculation

2nd FlexTimer: used for PFC (Power Factor Correction) integration

2-ch FlexTimer

8-ch FlexTimer

Motor Control PWMs: support all motor control types

High speed ADCs: provide more accurate real time data on what happening on the outside via over sample

8ch 12/16bit ADCs

8ch 12/16bit ADCs

Programmable Gain Amplifier

PGA: boosts small signals to provide more accurate inputs for the ADC's improving resolution.

Dual ADCs: capture Voltage & Current at exactly the same time, increasing system control

12bit DAC

DMA Controller

Programmable Delay Block

PDB: Simplifies control process by managing hardware without CPU intervention

12bit DAC: includes external pin used for setting the dynamic shift for ADC, or general arbitrary analog waveforms

6bit DAC

Analog Comparators

Inter Peripheral Crossbar

Inter Peripheral Crossbar: enables communication as your application demands it, simplifying pin out and reducing cross peripheral & CPU communication

6bit DAC: provides the reference to comparators

DMA: increases throughput of processor, benefiting the control algorithms by managing the data more efficiently

Analog Comparators: used to shutdown PWM output during an emergency; detecting BLDC zero crossing, over-voltage; over-current, restarting timers. They can reduce the external component usage and PCB layout complexity



Kinetis V Series KV1x: Block Diagram

Core/System

- 75MHz Cortex-M0+ with Hardware Divide & Square Root
- 4ch DMA

Memory

- **16/32/64/128KB Flash**
- **8/16KB SRAM**
- Option with FAC

Communications

- Multiple serial ports + **1 FlexCAN***

Analog

- 2 x 8ch 16-bit ADC
 - 1.2Msps in 12-bit mode (835ns)
- 1 x12-bit DAC
- 2 x ACMP with 6-bit DAC

Timers

- **Up to 2x6ch FlexTimer (PWM) ***
- Up to 4x2ch FlexTimer (PWM/Quad Dec.)
- Low Power Timer

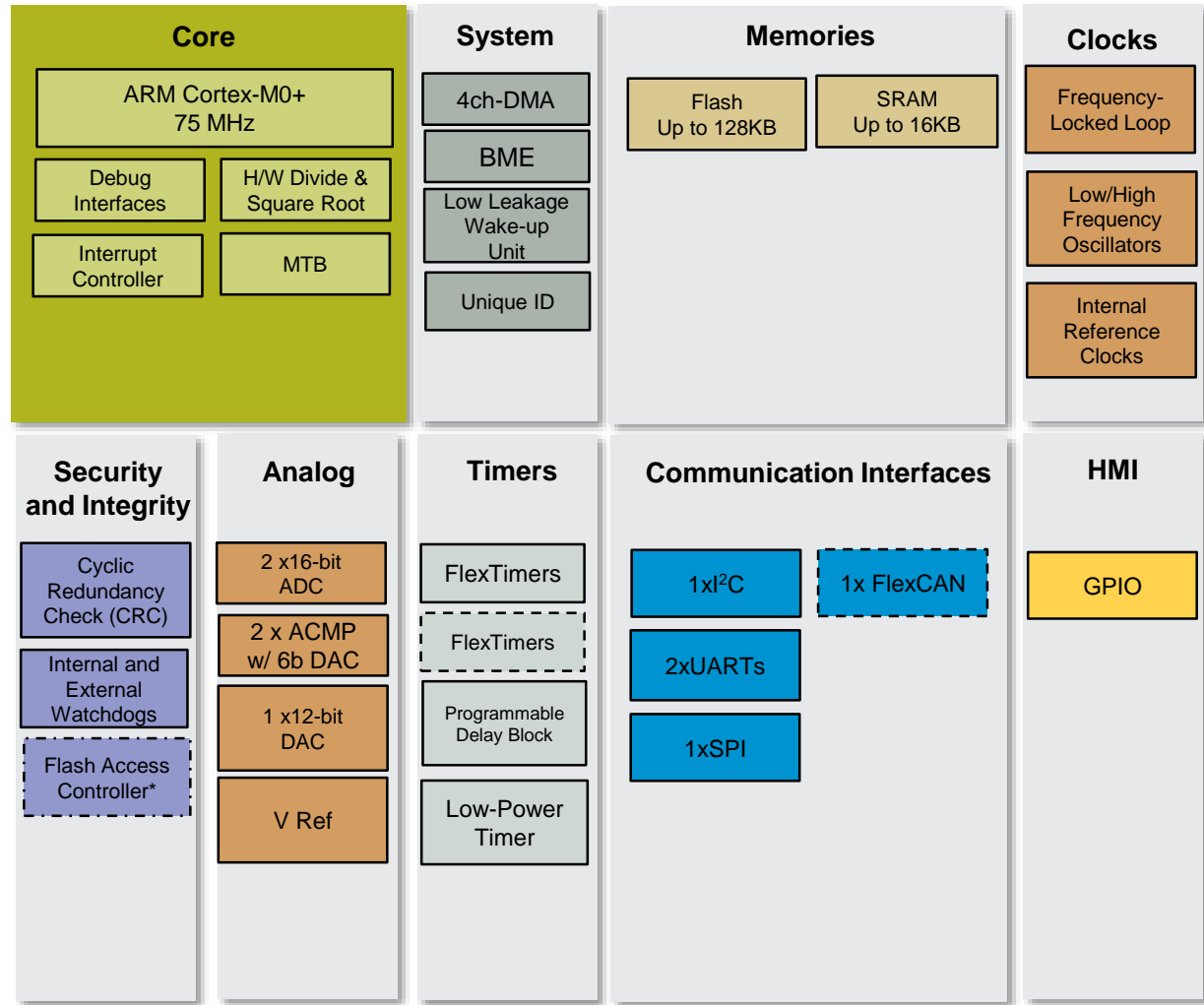
Other

- 32-bit CRC
- Up to 54 GPIO
- 1.71V-3.6V; -40 to 105C

Packages

- 32QFN, *32LQFP, 48LQFP, **64LQFP**
- * Package Your Way

From \$0.90 to \$1.56 @ 10k units



*Optional

Availability: 16 & 32KB in Production Now

64 & 128KB PK samples Now, Production July 2015



Kinetis V Series KV1x: Family Overview

Part Number	Freq.	Package	Flash	SRAM	FlexTimers	DAC	CAN	10K# SRP	Availability
MKV11Z128VLH7	75MHz	64LQFP	128KB	16KB	2x6ch; 4x2ch	1	1	\$1.56	July 15
MKV11Z128VLF7	75MHz	48LQFP	128KB	16KB	2x6ch; 4x2ch	1	1	\$1.43	July 15
MKV11Z128VFM7	75MHz	32QFN	128KB	16KB	2x6ch; 4x2ch	1	1	\$1.30	July 15
MKV11Z128VLC7*	75MHz	*32LQFP	128KB	16KB	2x6ch; 4x2ch	1	1	\$1.26	PYW
MKV11Z64VLH7	75MHz	64LQFP	64KB	16KB	2x6ch; 4x2ch	1	1	\$1.49	July 15
MKV11Z64VLF7	75MHz	48LQFP	64KB	16KB	2x6ch; 4x2ch	1	1	\$1.35	July 15
MKV11Z64VFM7	75MHz	32QFN	64KB	16KB	2x6ch; 4x2ch	1	1	\$1.20	July 15
MKV11Z64VLC7*	75MHz	*32LQFP	64KB	16KB	2x6ch; 4x2ch	1	1	\$1.15	PYW
MKV10Z128VLH7	75MHz	64LQFP	128KB	16KB	2x6ch; 4x2ch	1	-	\$1.52	July 15
MKV10Z128VLF7	75MHz	48LQFP	128KB	16KB	2x6ch; 4x2ch	1	-	\$1.39	July 15
MKV10Z128VFM7	75MHz	32QFN	128KB	16KB	2x6ch; 4x2ch	1	-	\$1.26	July 15
MKV10Z128VLC7*	75MHz	*32LQFP	128KB	16KB	2x6ch; 4x2ch	1	-	\$1.22	PYW
MKV10Z64VLH7	75MHz	64LQFP	64KB	16KB	2x6ch; 4x2ch	1	-	\$1.44	July 15
MKV10Z64VLF7	75MHz	48LQFP	64KB	16KB	2x6ch; 4x2ch	1	-	\$1.30	July 15
MKV10Z64VFM7	75MHz	32QFN	64KB	16KB	2x6ch; 4x2ch	1	-	\$1.15	July 15
MKV10Z64VLC7*	75MHz	*32LQFP	64KB	16KB	2x6ch; 4x2ch	1	-	\$1.09	PYW
MKV10Z32VLF7	75MHz	48LQFP	32KB	8KB	1x6ch; 2x2ch	1	-	\$1.19	Now
MKV10Z32VFM7	75MHz	32QFN	32KB	8KB	1x6ch; 2x2ch	1	-	\$1.04	Now
MKV10Z32VLC7	75MHz	32LQFP	32KB	8KB	1x6ch; 2x2ch	1	-	\$0.99	Now
MKV10Z16VLF7	75MHz	48LQFP	16KB	8KB	1x6ch; 2x2ch	1	-	\$1.10	Now
MKV10Z16VFM7	75MHz	32QFN	16KB	8KB	1x6ch; 2x2ch	1	-	\$0.95	Now
MKV10Z16VLC7	75MHz	32LQFP	16KB	8KB	1x6ch; 2x2ch	1	-	\$0.90	Now



Kinetis V Series KV3x: Block Diagram

Core/System

- Cortex-M4 @ 100/120MHz with FPU
- 4 or 16ch DMA

Memory

- 64/128/256/512KB Flash,
- 16/24/48/96KB SRAM
- FlexBus (512KB version only)
- Bootloader

Communications

- Multiple serial ports

Analog

- 2 x16-bit ADC: 1.2Msps in 12-bit mode
- Up to 2 x12-bit DAC
- 2 x ACMP with 6-bit DAC

Timers

- Up to 2x8ch FTM (PWM)
- 2x2ch FTM (PWM/Quad Dec.)
- Programmable Delay Block
- Low Power Timer

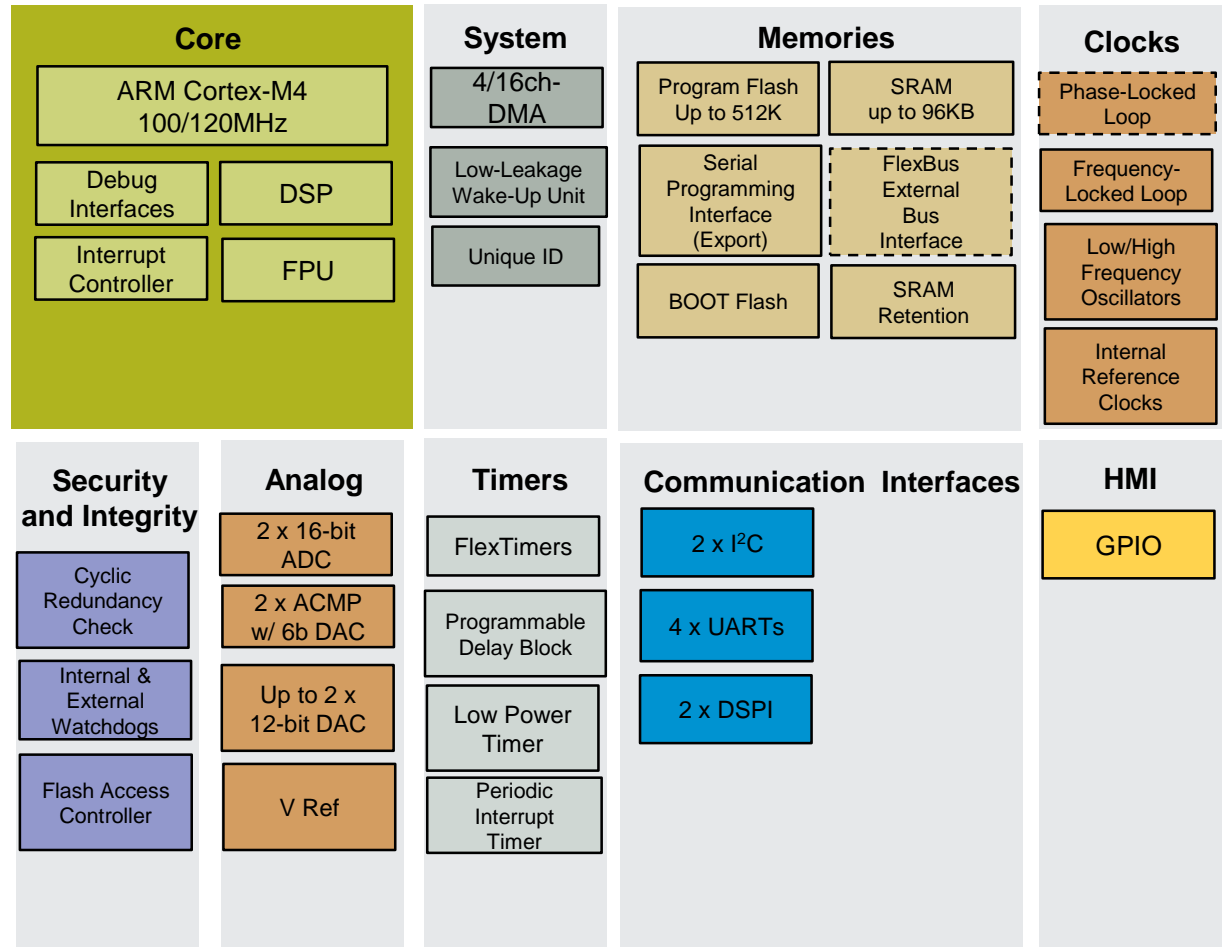
Other

- Up to 70 I/Os
- 6 high-drive I/Os (20mA) – SPI/I2C
- 1.71V-3.6V; -40 to 105C

Packages

- 32QFN, *48LQFP, 64/100LQFP
- *Alternative, non committed package

From \$1.19 to \$2.76 @ 10k units



Availability: Production Now

Kinetis V Series KV3x: Family Overview

Sub-Family	Part Number	Max. Freq.	Package	Flash	SRAM	Flex. Bus	DMA	PLL / FLL	FTMs	DAC	GPIO	I/O with Digital Filters	Suggested Resale Price (10K#)	Availability 'PK' engineering 'MK' production
KV31	MKV31F512VLL12	120MHz	100LQFP	512K	96KB	Yes	16-ch	PLL	2x8ch; 2x2ch	2	70	16	\$2.76	MK Now
	MKV31F512VLH12	120MHz	64LQFP	512K	96KB	Yes	16-ch	PLL	2x8ch; 2x2ch	2	46	16	\$2.63	MK Now
	MKV31F256VLL12	120MHz	100LQFP	256K	48KB	No	16-ch	PLL	1x8ch; 2x2ch	1	70	8	\$2.19	MK Now
	MKV31F256VLH12	120MHz	64LQFP	256K	48KB	No	16-ch	PLL	1x8ch; 2x2ch	1	46	8	\$2.06	MK Now
	MKV31F128VLL10	100MHz	100LQFP	128K	24KB	No	4-ch	FLL	1x8ch; 2x2ch	1	70	8	\$1.83	MK Now
	MKV31F128VLH10	100MHz	64LQFP	128K	24KB	No	4-ch	FLL	1x8ch; 2x2ch	1	46	8	\$1.71	MK Now
KV30	MKV30F128VLH10	100MHz	64LQFP	128K	16KB	No	4-ch	FLL	1x8ch; 2x2ch	1	46	8	\$1.66	MK Now
	MKV30F128VLF10	100MHz	*48LQFP	128K	16KB	No	4-ch	FLL	1x8ch; 2x2ch	1	35	8	\$1.53	MK Now
	MKV30F128VFM10	100MHz	32QFN	128K	16KB	No	4-ch	FLL	1x8ch; 2x2ch	1	26	8	\$1.40	MK Now
	MKV30F64VLH10	100MHz	64LQFP	64K	16KB	No	4-ch	FLL	1x8ch; 2x2ch	1	46	8	\$1.46	MK Now
	MKV30F64VLF10	100MHz	48LQFP	64K	16KB	No	4-ch	FLL	1x8ch; 2x2ch	1	35	8	\$1.33	MK Now
	MKV30F64VFM10	100MHz	32QFN	64K	16KB	No	4-ch	FLL	1x8ch; 2x2ch	1	26	8	\$1.19	MK Now

- *'Package Your Way' (alternative) package:
 - Documentation / pricing available @ NPI launch
 - Product available based on demand with samples within 3 months
 - Production dependent on customer demand (quick qualification cycle - typ. <5months)
 - Samples must be requested through Freescale sales

Kinetis V Series KV4x: Block Diagram

Core/System

- 168MHz Cortex-M4, FPU

Memory

- 64/128/256KB Flash @ 128bits wide w/ 128Byte cache
- 16/24/32KB SRAM

- Bootloader

Communications

- Multiple serial ports
- Up to 2 x CAN

Analog

- 2 x 8ch 12-bit ADC
 - Sampling at up to 4.1MS/s
 - PGA x1, x2, x4
- 12-bit DAC
- 4 x ACMP with 6-bit DAC

Timers

- Up to 12ch eFlexPWM
 - Up to 312ps PWM and PFM Resolution
- 2x8ch + 1x2ch FlexTimer (PWM)
- Quadrature Encoder
- 2 x Programmable Delay Blocks

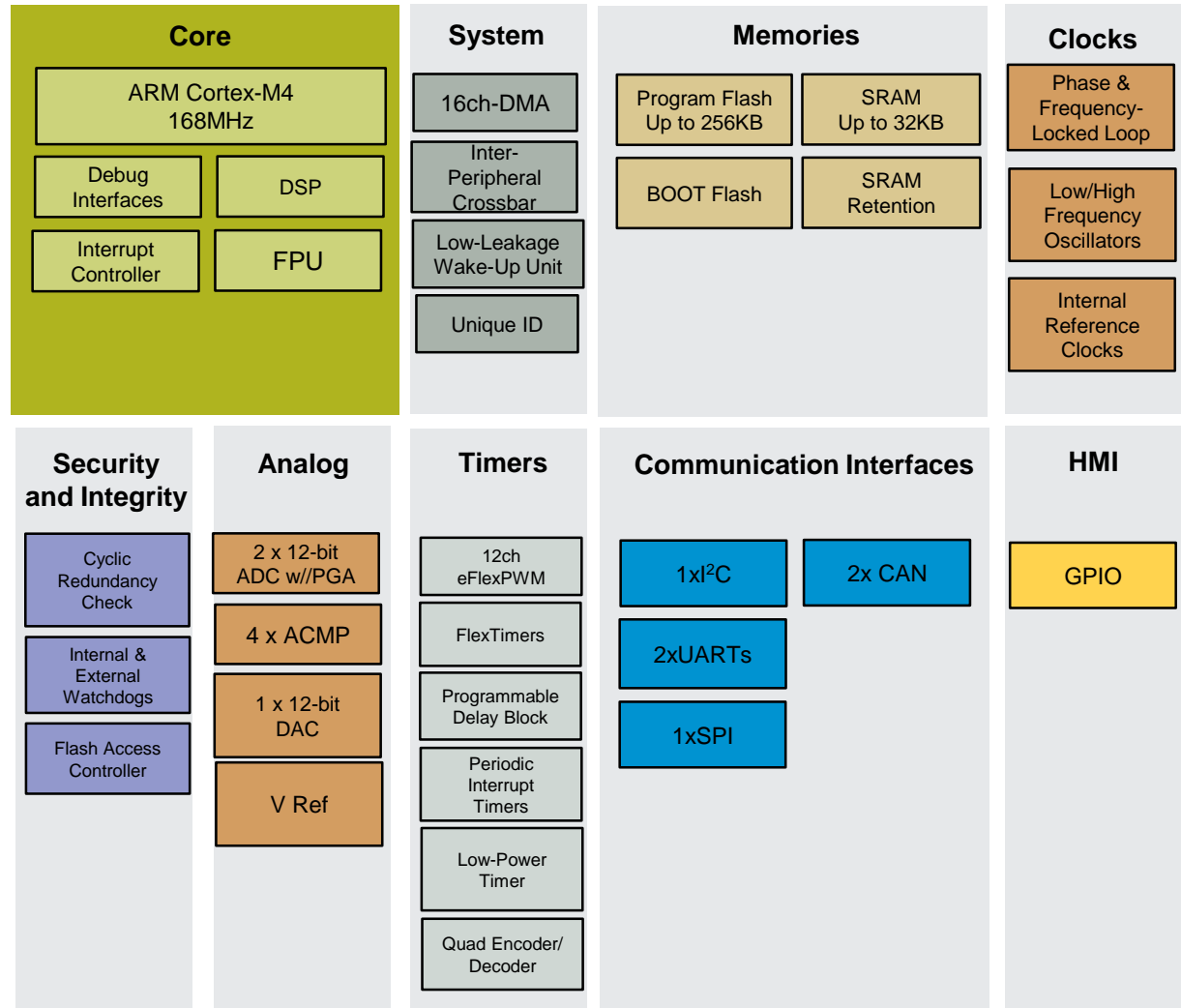
Other

- 32-bit CRC
- Inter-Peripheral Crossbar with AND/OR interface
- Up to 56 I/Os
- 1.71V-3.6V; -40 to 105oC

Packages

- *48LQFP, 64 LQFP & 100LQFP
- *Alternative, non committed package

From \$2.19 to \$3.41 @ 10k units



Availability: PK samples now, production Aug 2015

Kinetis V Series KV4x: Family Overview

Part Number	Freq. (MHz)	Pins	Flash / SRAM (KB)	ADC		PWM eFlexPWM	PWM Nano-Edge	PWM FlexTimers	DAC	CAN	Suggested Resale Price (10K#)	Availability
				ADC0	ADC1							
MKV46F256VLL16	168	100	256 / 32	20ch	18ch	1x8ch; 1x4ch	Yes	2x8ch; 1x2ch	1	2	\$3.41	PK now / MK Aug15
MKV46F256VLH16	168	64	256 / 32	18ch	11ch	1x8ch	Yes	1x8ch; 1x2ch	1	2	\$3.26	PK now / MK Aug15
MKV46F128VLL16	168	100	128 / 24	20ch	18ch	1x8ch; 1x4ch	Yes	2x8ch; 1x2ch	1	2	\$3.12	MK Aug15
MKV46F128VLH16	168	64	128 / 24	18ch	11ch	1x8ch	Yes	1x8ch; 1x2ch	1	2	\$2.97	MK Aug15
MKV44F128VLL16	168	100	128 / 24	20ch	18ch	1x8ch; 1x4ch	Yes	1x2ch	1	2	\$3.12	MK Aug15
MKV44F128VLH16	168	64	128 / 24	18ch	11ch	1x8ch	Yes	1x2ch	1	2	\$2.97	MK Aug15
MKV44F128VLF16*	168	48	128 / 24	13ch	6ch	1x8ch	Yes	1x2ch	1	1	\$2.87	MK Aug15
MKV44F64VLH16	168	64	64 / 16	18ch	11ch	1x8ch	Yes	1x2ch	1	2	\$2.67	MK Aug15
MKV44F64VLF16*	168	48	64 / 16	13ch	6ch	1x8ch	Yes	1x2ch	1	1	\$2.57	MK Aug15
MKV42F256VLL16	168	100	256 / 32	20ch	18ch	-	-	2x8ch; 1x2ch	-	2	\$3.03	MK Aug15
MKV42F256VLH16	168	64	256 / 32	18ch	11ch	-	-	1x8ch; 1x2ch	-	2	\$2.88	MK Aug15
MKV42F128VLL16	168	100	128 / 24	20ch	18ch	-	-	2x8ch; 1x2ch	-	2	\$2.74	MK Aug15
MKV42F128VLH16	168	64	128 / 24	18ch	11ch	-	-	1x8ch; 1x2ch	-	2	\$2.59	MK Aug15
MKV42F128VLF16*	168	48	128 / 24	13ch	6ch	-	-	1x8ch; 1x2ch	-	1	\$2.49	MK Aug15
MKV42F64VLH16	168	64	64 / 16	18ch	11ch	-	-	1x8ch; 1x2ch	-	2	\$2.29	* Package Your Way MK Aug15
MKV42F64VLF16*	168	48	64 / 16	13ch	6ch	-	-	1x8ch; 1x2ch	-	1	\$2.19	MK Aug15

Obsolete Part Number	Replacement Part Number
MKV4xFxxxVLx15	MKV4xFxxxVLx16
MKV45FxxxVLx15	MKV46FxxxVLx16
MKV43FxxxVLx15	MKV44FxxxVLx16
MKV41FxxxVLx15	MKV42FxxxVLx16
MKV40FxxxVLx15	MKV42FxxxVLx16



Kinetis KV5x MCU Family

Key Features:

Core/System

- 240MHz Cortex-M7 with FPU and 32ch DMA
- 16KB Instruction Cache / 8KB Data Cache

Memory

- 512KB/1MB Flash, 256bits wide, 128 Bytes cache
- 128/256KB SRAM
- Boot Flash

Communications

- Multiple serial ports
- 3 x FlexCAN

Analog

- 4 x 8ch 12-bit ADC
 - 5Msps Sample Time
- 1 x 16-bit SAR ADC
- 1 x12-bit DAC
- 4 x ACMP w/ 6b DAC

Timers

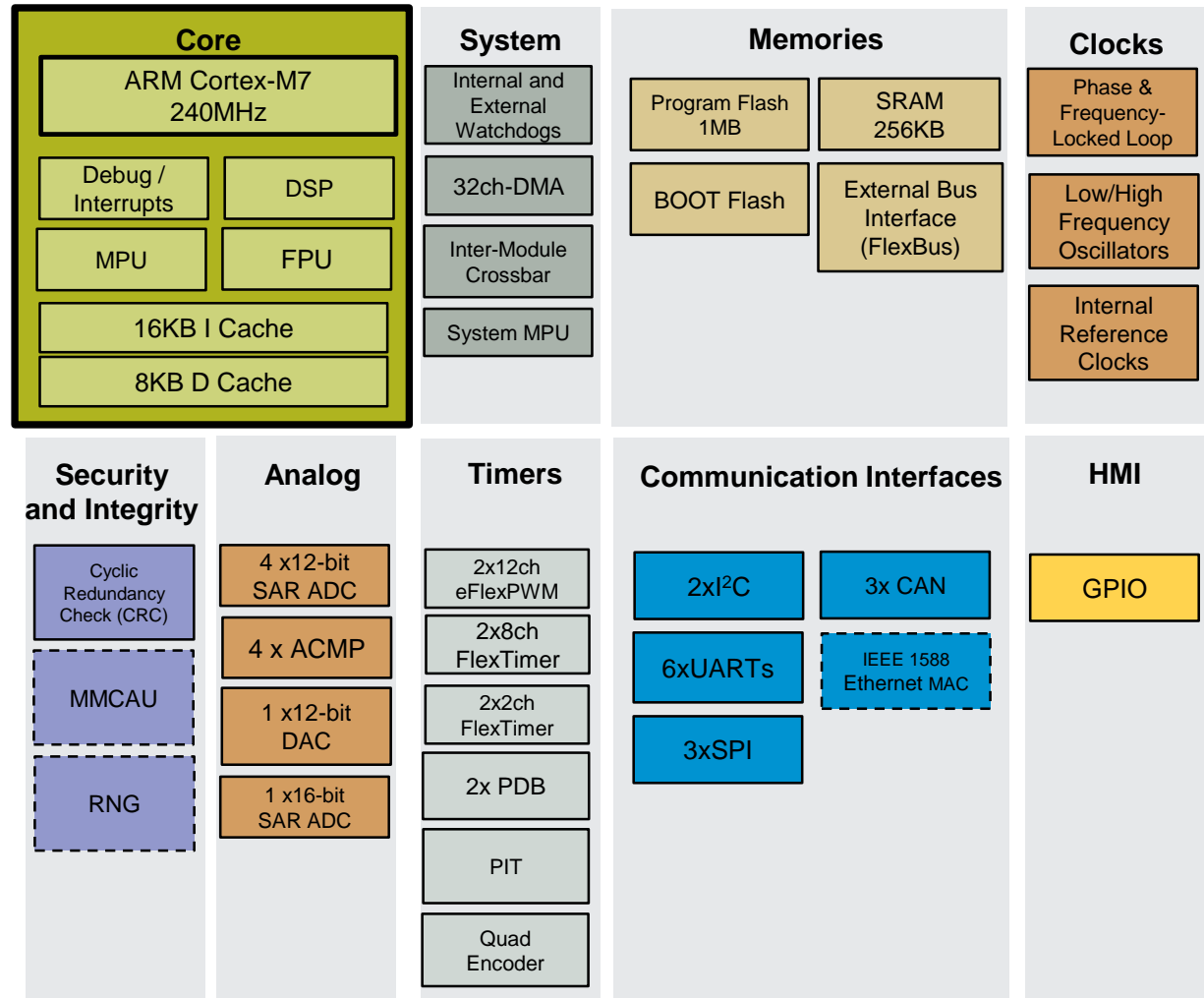
- 1 x 12ch eFlexPWM
 - 312ps PWM and PFM Resolution
- 1 x 12ch eFlexPWM
- 2x8ch FlexTimer (PWM)
- 2x2ch FlexTimer (PWM)
- Quadrature Encoder
- 2 x Programmable Delay Blocks
- Low-Power Timer

Others

- MMCAU & RNG
- 32-bit CRC
- Inter-module Crossbar Switch with AOI
- Memory Protection Unit
- 1.71V-3.6V; -40 to 105oC

Packages

- 100LQFP, 144LQFP, 144MAPBGA



Availability: PK samples Now for alpha customers, market launch Sept' 15 and production Dec 2015

Optional



Kinetis V Series KV5x: Family Overview

Part Number	Freq. (MHz)	Package	Flash / SRAM	E'net	12-BIT ADC (5Mps)	eFlexPWM	Nano-Edge Support	Flex Timers	CAN	Availability
MKV58F1M0VMD24	240MHz	144MAPBGA	1MB / 256KB	Yes	4 x 8ch	2x12ch	Yes	2x8ch, 2x2ch	3	PK: June '15 MK: Dec '15
MKV58F1M0VLQ24	240MHz	144LQFP	1MB / 256KB	Yes	4 x 8ch	2x12ch	Yes	2x8ch, 2x2ch	3	PK: June '15 MK: Dec '15
MKV58F1M0VLL24	240MHz	100LQFP	1MB / 256KB	Yes	4 x 8ch	2x12ch	Yes	2x8ch, 2x2ch	3	PK: Sept '15 MK: Dec '15
MKV56F1M0VMD24	240MHz	144MAPBGA	1MB / 256KB	No	4 x 8ch	2x12ch	Yes	2x8ch, 2x2ch	2	PK: Sept '15 MK: Dec '15
MKV56F1M0VLQ24	240MHz	144LQFP	1MB / 256KB	No	4 x 8ch	2x12ch	Yes	2x8ch, 2x2ch	2	PK: Sept '15 MK: Dec '15
MKV56F1M0VLL24	240MHz	100LQFP	1MB / 256KB	No	4 x 8ch	2x12ch	Yes	2x8ch, 2x2ch	2	PK: Sept '15 MK: Dec '15
MKV58F512VMD24*	240MHz	144MAPBGA	512KB / 128KB	Yes	4 x 8ch	2x12ch	Yes	2x8ch, 2x2ch	3	MK: Dec '15
MKV58F512VLQ24	240MHz	144LQFP	512KB / 128KB	Yes	4 x 8ch	2x12ch	Yes	2x8ch, 2x2ch	3	MK: Dec '15
MKV58F512VLL24	240MHz	100LQFP	512KB / 128KB	Yes	4 x 8ch	2x12ch	Yes	2x8ch, 2x2ch	3	MK: Dec '15
MKV56F512VMD24*	240MHz	144MAPBGA	512KB / 128KB	No	4 x 8ch	2x12ch	Yes	2x8ch, 2x2ch	2	MK: Dec '15
MKV56F512VLQ24	240MHz	144LQFP	512KB / 128KB	No	4 x 8ch	2x12ch	Yes	2x8ch, 2x2ch	2	MK: Dec '15
MKV56F512VLL24	240MHz	100LQFP	512KB / 128KB	No	4 x 8ch	2x12ch	Yes	2x8ch, 2x2ch	2	MK: Dec '15

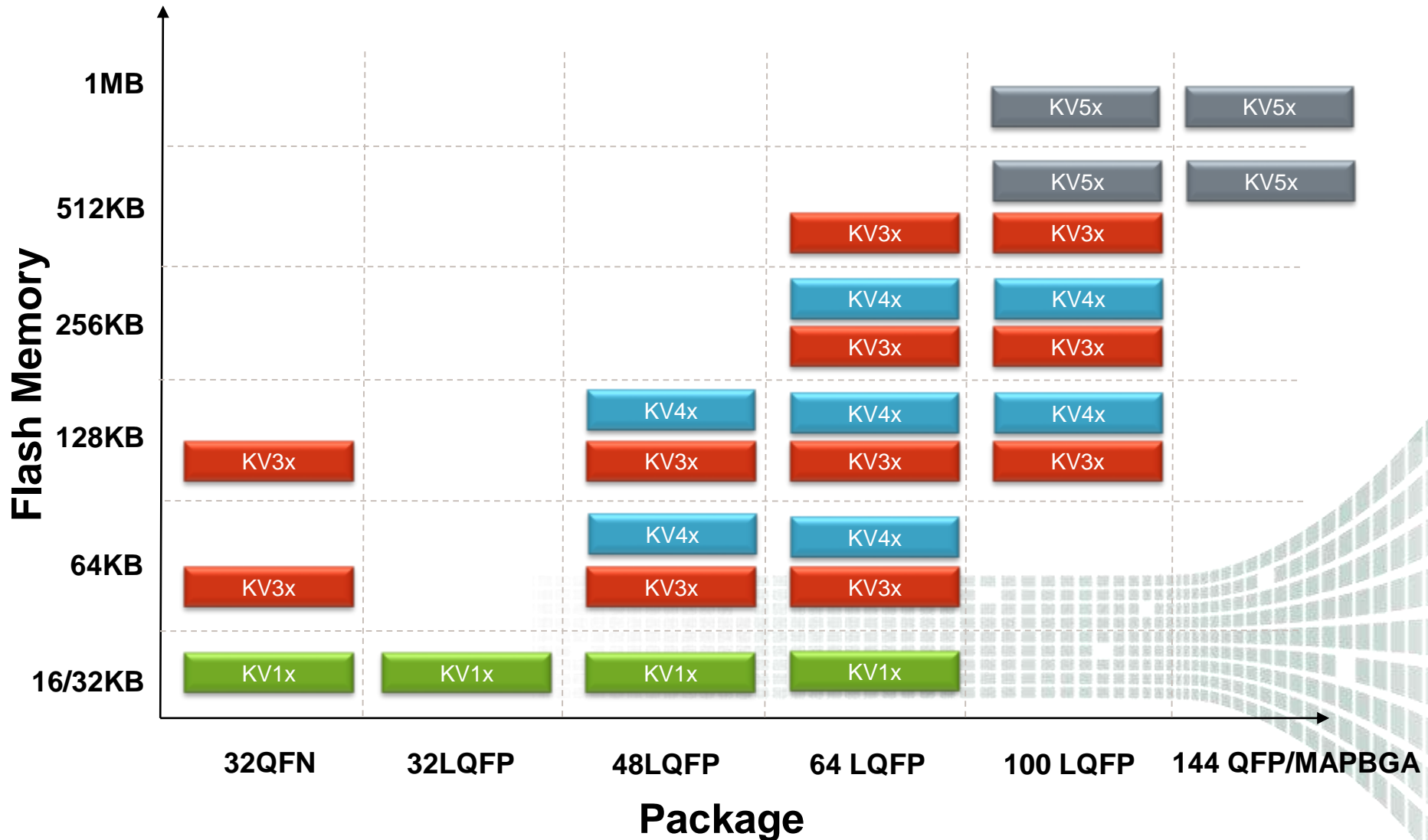
Kinetis V Series: Performance and Feature Scalability

Key Peripherals for Motor and Power Control Applications

MCU Family	Core	Memory	Motor Control Timers		ADC	DAC	ACMP	Comms.	Packages
			Flextimer	eFlexPWM					
KV5x	240MHz CM7 DSP + FPU	512kB-1MB Flash	2 x 8ch 1x 2ch FlexTimer	2 x 12ch eFlexPWM + Nano-Edge	4 x 12bit 5Msps, 1 x 16bit	1x 12-bit	4x ACMP with 6-bit DAC	Ethernet, 3 x CAN	144 pin 100 pin
KV4x	160MHz CM4 DSP + FPU	64-256kB Flash	2 x 8ch 1x 2ch FlexTimer	12ch eFlexPWM + Nano-Edge	2x 12bit 4.1Msps / 1.9Msps	2x 12-bit	4x ACMP with 6-bit DAC	2 x CAN	100 pin 64 pin 48 pin
KV3x	100/120MHz CM4 DSP + FPU	64-512kB Flash	2x 8ch 2x 2ch FlexTimer	-	2x 16-bit 1.2Msps	2x 12-bit	2x ACMP with 6-bit DAC	-	100 pin 64 pin 48 pin 32 pin
KV1x	75MHz CM0+ H/W DIV & SQRT	16-32kB Flash	1x 6ch 2x 2ch FlexTimer	-	2x 16-bit 1.2Msps	1x 12-bit	2x ACMP with 6-bit DAC	1 x CAN	64 pin 48 pin 32 pin

Scalable performance, timing and analog functionality based on application need

Kinetis V Series Package Scalability



Enablement



H/w Development Platforms – MCU Modules

Freedom Platform (FRDM-KVxx)



- Entry-level developer
- Compatible with FRDM motor driver boards (BLDC/PMSM)
- Voltage: 12-48V
- Price: \$20
- Availability:
 - [FRDM-KV10Z](#): Aug '15
 - [FRDM-KV31F](#): Jul '15
- Supported devices
 - KV1x, KV3x

Tower Platform (TWR-KVxx)



- Professional developer
- Highly scalable with large range of plug-in cards including motor driver board (TWR-MC-LV3PH)
- Voltage: 12-50V
- Price: from \$100
- Availability:
 - [TWR-KV10Z32](#): now
 - [TWR-KV32F120M](#): now
 - [TWR-KV46F150M](#): now
- Supported devices
 - KV1x, KV3x, KV4x, KV5x

High Voltage Platform (HVP-MC3PH)



- 115/230 volt, 1KW 3-ph motor control development platform for BLDC, PMSM and ACIM motors of >1Hp.
- Main board with inverter & PFC circuitry supports plug-in controller cards for Kinetis KV1x/KV3x/KV4x MCUs and MC56Fxxxx DSCs
- Voltage: 85 to 240V
- Price: \$600 (main board + KV46 card)
- Controller cards: KV10/31/46 MCU & 56F827xx DSC (\$50 each)
- Availability:
 - [HVP-MC3PH](#): now (includes [HVP-KV46F150M](#) card)
 - [HVP-KV10Z32](#): now
 - [HVP-KV31F120M](#): now
 - [HVP-KV46F150M](#): now
- Supported devices
 - KV1x, KV3x, KV4x, KV5x



H/w Development Platforms – Motor Driver Modules

Freedom Platform (FRDM-MC-LVxxxx)



- FRDM-MC-LVBLDC: \$30
 - 12V, 5Amp, 60W
 - Trapezoidal control algorithm
- FRDM-MC-LVPMSM: \$50
 - 48V, 5Amp, 240W
 - Sinusoidal control algorithm
- Partner motors available
- Availability:
 - [FRDM-MC-LVBLDC](#): Aug '15
 - [FRDM-MC-LVPMSM](#): Jul '15
- Supported devices
 - KV1x, KV3x

Tower Platform (TWR-MC-LV3PH)



- Low voltage motor driver module, included BLDC motor
- Voltage: 12-24/50V
- Output: 8Amp, 400W
- Over current & under voltage protection, encoder/hall sensor sensing circuitry
- Supported architectures: 3-phase BLDC & PMSM
- Price: \$249 (includes motor)
- Availability:
 - [TWR-MC-LV3PH](#): now
- Supported devices
 - KV1x, KV3x, KV4x, KV5x

High Voltage Platform (HVP-MC3PH)



- 115/230 volt, 1KW 3-ph motor control development platform for BLDC, PMSM and ACIM motors of >1Hp.
- Main board with inverter & PFC circuitry supports plug-in controller cards for Kinetis KV1x/KV3x/KV4x MCUs
- Voltage: 85 to 240V
- Price: \$600 (main board + KV46 card)
- Availability:
 - [HVP-MC3PH](#): now (includes [HVP-KV46F150M](#) card)
 - [HVP-KV10Z32](#): now
 - [HVP-KV31F120M](#): now
 - [HVP-KV46F150M](#): now
 - [HVP-56F82748](#): now
- Supported devices
 - KV1x, KV3x, KV4x, KV5x



S/w Development Platforms

Freedom Platform (FRDM-MC-LVxxxx)



- BLDC Reference Solution incorporating FSL Embedded Software Library: Q3 2015
- PMSM Reference Solution incorporating FSL Embedded Software Library: Q3 2015
- Kinetis Motor Suite PMSM Sensored and Sensorless Solutions: Q3 2015

Tower Platform (TWR-MC-LV3PH)



- BLDC Reference Solution incorporating FSL Embedded Software Library
- PMSM Reference Solution incorporating FSL Embedded Software Library
- Kinetis Motor Suite PMSM Sensor and Sensorless Solutions: Q3 2015

High Voltage Platform (HVP-MC3PH)



- BLDC Reference Solution incorporating FSL Embedded Software Library
- PMSM Reference Solution incorporating FSL Embedded Software Library
- ACIM Reference Solution incorporating FSL Embedded Software Library: Oct 2015
- Kinetis Motor Suite PMSM Sensor and Sensorless Solutions: Q3 2015
- Kinetis Motor Suite ACIM Sensorless Solution: Q4 2015

S/w Enablement Guide

Kinetis Motor Suite



- Integrated h/w & s/w tools that allow any developer to identify, tune and control any type of 3-ph synchronous or asynchronous motor of any power level
- Disturbance rejection control algorithm ensures high performance even in highly dynamic operating conditions
- Motor control algorithms pre-programmed into the MCU
- Intuitive GUI for easy motor configuration & tuning
- Cost: ~20% adder to standard MCU price
- Supported devices
 - KV3x Q315, then KV1x & KV4x

Embedded Software Libraries



- Libraries of software algorithms for Math, Motor Control, Power Conversion, Filters and Advanced functions. ~200 algorithms available
- Core self test library for IEC60730 with UL Certifications for CM0+
- Free option: binary code released through FSL.com
- Paid option: source code, optimized code, advanced functions (including patented)
- **Cost: free of charge**
- Supported devices
 - KV1x, KV3x, KV4x,
 - KV5x (Sept '15)

Kinetis SDK & Processor Expert Code Generator



- SDK – a complete software framework for developing applications across all Kinetis MCUs. h/w abstraction, peripheral drivers, stacks, RTOS's, utilities, and usage examples; delivered in C source
- Processor Expert – GUI Eclipse plug-in tool for creating and configuring software and peripheral drivers quickly & easily
- **Cost: free of charge**
- Supported devices
 - KV1x, KV3x & KV4x
 - KV5x (Sept '15)

MQX RTOS



- Commercial-grade MCU software platform at no cost with optional support packages
- RTOS Kernel, Real Time TCP/IP Communication Suite, File System, USB Host/Device Stack and Board Support Packages
- **Cost: free of charge**
- Supported devices
 - KV3x & KV4x
 - KV5x (Sept '15)



S/w Enablement Guide

MCAT (Motor Control Application Tuner)



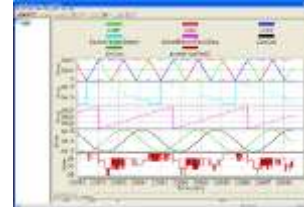
- Complimentary GUI based run-time debug monitor and data visualization tool
- Replaces debugger in situations when the core can not be simply stopped, ideal for motor control and power conversion application development
- <http://www.youtube.com/watch?v=vKV1xu8ecdg>
- **Cost: free of charge**
- Supported devices
 - KV1x, KV3x, KV4x,
 - KV5x (Sept '15)

FreeMASTER



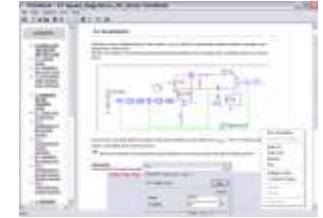
- GUI based FreeMASTER plug-in tool that provides real-time monitoring, tuning and updating of motor control system parameters
- Provided as a plug-in for the FreeMASTER tool. Designed to work with FSL Ref. Design s/w
- <http://www.youtube.com/watch?v=ZsLQzSTnhg0>
- **Cost: free of charge**
- Supported devices
 - KV1x, KV3x, KV4x,
 - KV5x (Sept '15)

Motor Control Toolbox



- MATLAB™/Simulink™ modelling environment motor control plug-in tool for automatic code generation. Supports multiple compilers. FreeMASTER compatible.
- <http://www.youtube.com/watch?v=5pTuOEwq78g>
- Cost: \$8K license cost
- Supported devices
 - KV1x, KV3x, KV4x
 - KV5x (Q3/5 2015)

POWERSIM Motor Control Design Suite



- Simulation software specifically designed for power electronics and motor drives
- Cost: \$700 (1st license)
- Supported devices
 - KV3x (Q3 2015)
 - Others to follow



New Kinetis Motor Suite

- A highly intuitive, high performance motor control development solution that accelerates the design and deployment of motor control applications
- All motor configuration and control carried out through the graphical user interface
- **Simplicity**
 - On-chip expertise eliminates the need for in-depth knowledge of motor control, allowing those with limited experience to develop an application
- **Performance**
 - Proprietary disturbance compensating control from LineStream Technologies allows the motor to operate across speeds & loads, extends machine life, and improves energy efficiency



Guiding Principles

Radical Simplicity

Pre-programmed, on-chip expertise
connected to streamlined user
interface

Powerful Performance

Proprietary disturbance
compensating control from
LineStream Technologies

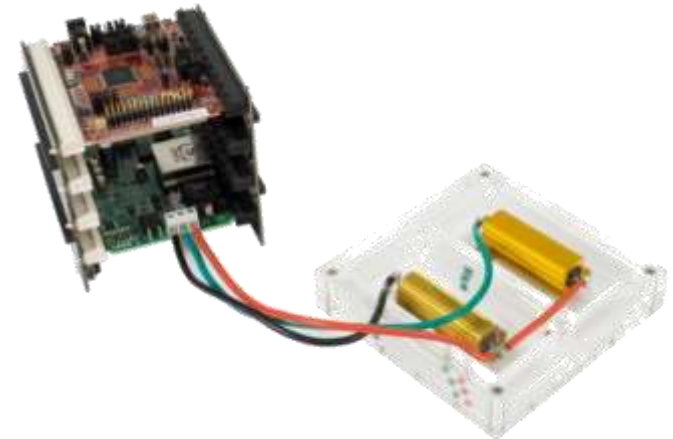
Designed for the Mass Market

Enables any developer, regardless of
experience, to efficiently run a
motor out of the box



TWR-SMPS-LVFB: Overview

- Safe, low voltage hardware for full-bridge converter with synchronous rectification
- Low voltage, low cost modular board for topology used in high voltage, high power applications such as server and telecom power supplies
- On board dynamic load circuit
- Compatible with Kinetis V series MCUs and Digital Signal Controllers (DSCs) Tower MCU Modules
- Input voltage 20-30V DC or AC-DC adapter with 24V @ 3A
- Output power up to 40 watt, output voltage 5V @ 8A
- Cost effective design, safe, robust, easy to use
- Suitable for:
 - Average current mode control implementation
 - Peak current mode control implementation
 - Voltage mode control implementation
- TWR card also can be used to implement Phase shift full bridge topology
- CE/FCC certified



\$190 SRP



SMPS Resonant Converter (LLC) Reference Design

- **SMPS Topology**
 - Primary Side: Two Phase Interleaved PFC (Average Current Control)
 - Secondary Side: Half Bridge LLC Resonant Converter with Synchronous Rectification for 12V output
 - Additional Synchronous Buck Converter for 5V output
- **Fully Digital Control**
 - Secondary Side: Kinetis V series KV46 MCU
- **Input voltage**
 - 85-265Vac @ 45-65Hz
- **Output voltage**
 - 12V/41 Amps (max.)
 - 5V/25 Amps (max.)
- **Output Power**
 - 500W shared by both voltage outputs. The power limit can be set individually by SW for each voltage output.
- **Communication**
 - PM Bus communication (HW ready)
 - CAN Communication (HW ready)
 - Communication with PC using USB
- **Full Fault Protection**
 - Over-voltage, Over-current, over-temp. on both primary and secondary side. Active controlled cooling



Kinetic V Series: KV5x Quadcopter Demo

Tear Down



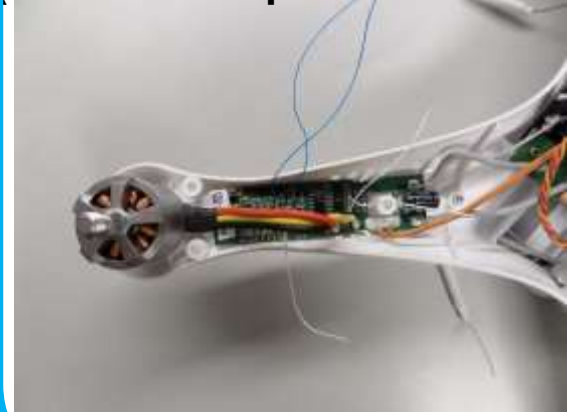
Disassembly:

<https://www.youtube.com/watch?v=YqmdU4bFe3w>

Flight Control Unit



ESC
Embedded Speed Controller



Parts being replaced with FSL ICs

ESC BOM (4 ESCs per drone) (partial list - only relevant items)	Part Number
Motor	DJI 2212 920kv
MCU (1 MCU per ESC, 4 in total)	C8051F330 MPU 8K
Transistors (Q2, Q3, Q4), 3 of	NXP PUMH10
Transistors (Q5, Q6, Q7), 3 of	NXP PUMZ1
Power MOSFETS (Q8, Q10, Q12)	AO4430 (IRF7455)
Power MOSFETS (Q9, Q11, Q13)	AO4407A (IRF7425)



- 4 ESC modules per drone
- Each ESC module contains 1 x SiLabs 8-bit 8051 MCU, and 3 x NXP PUMH10 and 3 x NXP PUMZ1 MOSFETS which drive the gates discretely
- Basic PWM based control scheme used between flight control unit and motor controller
 - PWM command from Flight Control unit determines applied voltage on the motor



Kinetic V Series: KV5x Quadcopter Demo

New FSL ESC Module (KV5x MCU & GD3000 Motor Driver IC)



- **1x KV5x MCU** driving all 4 motors using 6-step BLDC open loop control algorithm
Replaces 4x 8-bit MCUs!!
- KV4x (Cortex-M4) design also available
- **4x MC34GD3000 motor pre-drivers** - existing MC34937A in 56QFN, 8x8mm
Replaces 24 transistors!!
- KV5x ESC design could be expanded to include
 - FOC algorithm...for quieter motor operation e.g. filming applications
 - 'NAZA' Flight Stability Controller using FSL GYRO

See it in the FTF TechLab!

Summary

Scalable, high-performance MCUs for next-generation motor control and digital power conversion applications

- **Addressing market requirements**

- High-performance MCUs with fast, high precision analog and timing peripherals covering multiple motor control use cases. Advanced DSC peripherals for the most demanding applications

- **Product family scalability**

- From the industry's fastest Cortex-M0+ MCU, to 240 MHz Cortex-M7 MCUs with FPU support. Multiple memory, peripheral and package options for evolving end product feature and price requirements

- **Enabling every customer**

- Large range of tools including free software libraries and the new Kinetis motor suite designed for simpler, faster and more cost-effective system development. World class application expertise

www.freescale.com/kinetis/vseries





www.Freescale.com