### mail

Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from, Europe, America and south Asia, supplying obsolete and hard-to-find components to meet their specific needs.

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### Wireless ZigBee® and Sub-GHz Solution SoC/SiP Supporting Internet of Things (IoT) AMF-IND-T0274

**Derrick Klotz** 



Hearcoin, the Preserval Kogs, ARINE, C.S. Cold/151: Cold/Miness, Cold/16, Cold/16



## Wireless connectivity for the IoT



Professor David E. Culler University of California, Berkeley CWSN Keynote. Sept. 26, 2011



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## MCU/MPU Portfolio - Current & Future

#### i.MX Applications Processors Your Interface to the

#### Kinetis L Series

Ultra-low power/cost ARM Cortex-M0+ MCU families from 48MHz / 8KB with mixed-signal, connectivity and HMI features in low pin-count packages.

#### Kinetis E Series Robust, 5V ARM Cortex-M0+ & ARM Cortex-M4 MCU families for use in high electrical noise environments. Safety features for highreliability applications.

#### Kinetis K Series Industry-first ARM

Cortex-M4 MCU families from 50MHz / 32KB with low power, FlexMemory, mixed-signal and broad connectivity, HMI and security features.

#### Vybrid Controller Solutions Rich Apps in Real Time.

#### General Purpose

#### Segment Focused

#### **Kinetis W Series**

Wireless & PLC wired connectivity **ARM Cortex-M4 and M0+** MCU families with classleading sub-1 GHz and 2.4 GHz RF transceivers.

#### Kinetis M Series

High accuracy metrology **ARM Cortex-M0+** MCU families for single chip smart meter implementations.

Integration



Presents, the Freenake login, MVMws, D.S., Code/EBT, OxdeRamin, OxdFine, OxdFine, OxdFine, OxdFine, Delay, Ethilent Solutions legis, Kitesta, incoled/01, PBC, PrevenDUCC, Processor Darlet, Caroli, Carona, Eurobasan, Inte Statisticane logi, StatCare, Symptrey and Vorsiba and statisticane logis, Parallel Barccodoutz, Inc., Rey, U.S. Ru, E.T., Ott. Antari, Berlit, BerSchot, Carolea, Fastulane, Layersage, Magel, MSC, Pathore in a Package, Caroli Gonveya, OxDC Engine, Rady May, SMMT4003, Treve, Tacholotti, Vymal and Tamica and Statisticane of Research Early MSC, Pathore in a Package, Caroli Gonveya, OxDC Engine, Rady May, Caroli Technolotti, Vymal and Tamica and Statisticane of Research Early MSC. The Oxford Caroline and and the paperty in their Angeotate events. 5 ND1, Research Statisticane Statisticane Statisticanes and Statistican



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Renewable Sources	
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MPC8xxx, QorIQ, Kinetis

Distribution & Substation Automation, Protection, Control and Monitoring

MSC9130 , MPC8xxx, QorlQ, Kinetis Data Concentrator P102x, MPC8308,

i.MX28

Area Network (NAN) RF: Sub Gig 802.15.4g Kinetis KW01 PLC: G3/ PRIME

Neighborhood

Smart Electricity Meters

1-ph, 2-ph, 3-ph, Sub-Metering

Kinetis, Vybrid

Home Area Network (HAN) ZigBee

Kinetis KW2x

Home Energy Management (HEM)

> i.MX283 Vybrid



Presents, the Freesede logs, ADNo. D.S., Color/EST, Ondelfanico, Didffini, ColdFini, C

**OFDM - Kinetis** 



# KW20

### KW2x – 2.4 GHz Smart Energy & Home Automation Solution from Freescale

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### NP What is Kinetis KW2x?

- The new Kinetis KW2x is Freescale next generation 2.4 GHz
   802.15.4 platform
- The Kinetis KW2x platform integrates a class leading RF transceiver, ARM Cortex-M4 core and a robust feature set for a reliable, secure and low-power IEEE® 802.15.4 wireless solution.
- Wireless protocol software is seamlessly integrated into Kinetis software development tools for rapid creation of embedded systems.





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## NP.eescale Smart Metering Solutions – Home Are Network





## Kinetis MKW2x Wireless MCU



#### Core System Memories **RF** Transceiver ARM Cortex<sup>™</sup>-M4 **Internal and Program Flash** IEEE 802.15.4 2006 **50 MHz External Watchdogs** (Up to 512 KB) 2.4 GHz DMA Fast Antenna DSP FlexMemory Option Diversity Low Leakage Wake-**64 KB FlexNVM** Up Unit **4 KB FlexRAM Debug Interfaces** (MKW21D256 only) **Dual PAN ID** Analog Interrupt Controller 32 MHz Osc SRAM (Up to 64 KB) **SPI Interface** Communications Timers I<sup>2</sup>C **Flex Timer** Clocks Security SPI Programmable Phase-Locked Loop **Delay Block** Cyclic Redundancy **UART (ISO 7816)** Check (CRC) **Frequency Locked Periodic Interrupt** Timers USB On-The-Go (H) **Tamper Detect** Low / High Low Power Timer Cryptography Frequency Osc. USB Charger Detect **Authentication Unit** Independent Real Internal Reference **Random Number** USB Voltage Regulator Time Clock Clocks Generator

Device	Flash	RAM	Feature	Package
MKW21D256VHA5	256 KB	32 KB	No USB	8x8 63-pin LGA
MKW21D512VHA5	512 KB	64 KB	No USB	8x8 63-pin LGA
MKW22D512VHA5	512 KB	64 KB	USB	8x8 63-pin LGA
MKW24D512VHA5	512 KB	64 KB	USB and Smart Energy 2.0	8x8 63-pin LGA

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#### CPU •

- 50 MHz Cortex M4 CPU core
- Up to 512KB Flash & up to 64KB SRAM
- Optional (MKW21D256): 64 KB FlexNVM & 4 KB FlexRAM
- Typical current: 250 uA/Mhz run, 1.7uA RTC standby
- Radio Transceiver. 2.4GHz
  - IEEE-802.15.4 compliant
  - -102 dBm Rx sensitivity and +10dBm Tx output power
  - Peak typical current: 17mA Tx and 19mA Rx
  - Dual Personal Area Network (PAN) support in hardware
  - Run two RF networks simultaneously
  - Antenna diversity with automatic antenna selection

#### Security

- Active and passive tamper detection with RTC timestamp
- Crypto engine: DES, 3DES, AES 128-256, SHA-1, SHA-256, MD5, RNG

#### Software

- 812.15.4 2006 MAC
- RF4CE, ZigBee Pro, ZigBee IP
- ZigBee Profiles: ZSE, ZHA, ZHC, ZRC
- Freescale IPv6 Mote Stack
- MQX Lite RTOS

#### System

- UART, SPI, I2C, optional USB 2.0 FS/LS H/D/OTG
- 16-bit ADC
- Operating range: 1.8 V to 3.6 V, -40C to +105C



## Cortex-M4 MCU

- ARM Cortex M4 with DSP
- Supports up to 50Mhz (1.25 DMIPS/MHz)
- 16-channel DMA
  - Supports up to 128-bit data values
  - Programmable
- Configurable nested vector interupt controller (NVIC)
- Wake-up Interrupt Controller (WIC)
- Advanced debug and trace
- Hardware CRC
- Independent-clocked COP
- External watchdog
- 10 low power modes
  - Low-leakage wake-up, low power timer and low power RTC
  - Fast wakeup times
- FlexTimers
  - Programmable Interrupt Timer (PIT)
  - PWM support

freescale<sup>™</sup>

Carrier Modulator Timer



Presents: the Freestade logs. MONo. D.S. Code/EER, Cade/Marrier, Old/Fire, Cod/Fire, C.Mass, InvErway, Efficient Soldions legs, Minuta, mobile/CI, PEG, PreverQUCCC, Processor Rayer, Caroli, Garina, Earlankasan, Rai Sale/Kasar Rag, ResChing, Buryl Loving, and Voralla are trailerated or Freestade Manconducter, too, Rey, U.S. Pet, B. Tr. Ott. Antar, Bel/R, BedStack, Carolian, Fatabasan, Mayny, MRC, Parthers et a Pantaga, Ourio Gonorega, U.S.C. Engin B. Sale Field, Sino, Marka, Tableck, Vytnil and Trains: an Mathematic R Freestade Research Research and Caroling, Ourio Gonorega, U.S.C. Engin B. Rad, Pay, Sale/Carol, Vytnil and Trains: an Mathematic R Freestade Research Res. A Core product or evideo name are the angeotax averse or 2011 Freestade Resonance for the

### Connectivity and Communication

- SPI
  - Full-duplex
  - Master and slave mode
  - Buffered transmit and receive with FIFOs
- DMA support for FIFOs
- Inter-Integrated Circuit (I2C)
- I2C SMBus version 2 compatible
- Up to 100 Kbps
- Multi-master operation
- DMA support
- UART
  - Full-duplex operation
  - Programmable TX/RX polarity
  - Idle line or address mark wakeup
  - Hardware parity
  - DMA request
- USB Interface OTG
  - USB 2.0 compliant
  - On-chip FS and LS transceiver
  - USB host mode
  - USB device mode

freescale

- Suspend mode /low power
- Supports HS with off-chip transceiver



Presents: The Freesetek logs, MONov, D.S., Code/EST, Cade/Marrier, Old/Fire, Cold/Fire, C.Mare, Inv Energy Ethient Soldions logs, Kineta, rednikOT, PEG, FreedQUCC, Processor Royer, Caroli, Carona, Earlehauer, Na Sale/Aurar Ng, Structure, Structure, and Vortilla var trailenates of Freezet Nanccoducts; no. Neg. U.S. Pist. Th. Ot. Antas, Selfit, BedStack, Carolia, Fast, Layresage, Mayriv, MSC, Parther et al. Partiage, Octo: Compress, Neg. Visit, Structure, Tubolcek, Vytmi and Trains: an Networks of Freezet Nanccoducts; No. X. Other protein or extremate and an text any structure and protect any encoduct and text and t

## Security and Reliability core

- Tamper detect
  - External tamper detect
  - 256-bit secure storage (erased on tamper)
- CRC
- Hardware encryption
- Cryptography Acceleration Unit (CAU)
- Random Number Generator (RNG)
  - FIPS compliant





Presents, the Freenate logs, MWex, 0.5, Code/EST, Code/Est, Oxf/Fin, Oxf/Fin, C.Mars, the Energy Efficient Solutions legs, Kinste, models/CL, PGS, PreveOUCC, Processor Rayer, CodO, Carina, Earlehauer, Inte Satel-Auar Ray, RayCare, Sangtary and VortiSa are tradematic of Freenate Banccoducts; Inc., Neg. U.S. Pet, 5 Tro. Dt. Antar, Stelfs, BedSate, Carelus, Feas, Layrenae, MayrV, MRC, Pathor et a Pantage, OxfC Gonweg, OXOC Engine, Ray (FV) 2001 (1990); Trees, Tubolant, Vytral and Tamica are bacterias of Freedmatic Researcharts; for 34 One protein or evolve means are to anyour; if the respective averes of 2011 Freediate Solutions; Forematical Tamica are bacterias and Freedmatics; for 34 One protein or evolve means are to anyour; if the respective averes of 2011 Freediate Solutions; Fore-Ray (1990); Fore-Ray (

## Transceiver Features

#### **Transceiver Features**

- 2.4 GHz frequency band
  - Supports 2.36 to 2.4 GHz Medical Band
- 802.15.4 compliant
  - 250 kbps data rate
  - O-QPSK modulation
  - DSSS with 5 MHz channels
  - 16 selectable channels
- Supports packet and bit stream mode
- 802.15.4 Packet Processor
- Output power varience +/- 2 dBm
- Programmable output power from -30 to +10 dBm
  - 2dB steps
- Low power receive mode
- 32 Mhz crystal oscillator with on board trim capability





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### Differential input/output port

- Supports external PA/LNA
- Single ended antenna option
  - Integrated transmit/receive switch
- Antenna diversity option
- Automatic Gain Control (AGC)
- Receive Strength Signal Indicator (RSSI)
- Temperature compensation





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## Antenna Diversity

### Diversity

- GPIO for Antenna Diversity control
- FAD (Fast Antenna Diversity)
  - Off
  - Preamble detect





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Dual Channel Example			nple	Preamb	802.15.4 Packet (PAN 1)		Sequence Idle	
Channel Switch	Preamble Search PAN 2	Channel Switch	Preamble Searc PAN 1	:h	Active PAN 1	Channel Switch	Preamble S	earch PAN 2



Presents, the Freeholds logs, AVNex, D.S., Cob/TEST, Cadulfarios, OxtFine, OxtFine, OxtFine, OxtFine, Texture, Brenzy Ethiant Solutions lags, Kitesta, mobileDT, PEG, PreverGBCC, Processor Essee, Confl, Danna, Estelwatar, les Salekarar logs, RecCine, Spripting and Vorliza with tailenakar of Freezen Male, Park, Statist, Conflict, California, Lightmann, Magni, MCC, Falcher, Spripting, and Conflict, Conflict, California, Lightmann, Magni, MCC, Falcher, a y Parkag, OraG, Gonnega, OxCC, Empres, Real, Park, Statist, California, Lightmann, Magni, MCC, Falcher, a y Parkag, OraG, Gonnega, OxCC, Empres, Real, Park, Statist, California, Lightmann, Li, Altoria, Politar, California, and an enginest at the respective anional Statistication Statistications (Statistications). In: Altoretication of source remote and the program of the respective anional Statistications (Statistications). In: Altoretications (Statistications). In: Altoretications). In: Altoretications). In: Altoretications (Statistications). In: Altoretications). In: Alto



 Smart Energy Network (Utility)







- Smart Energy Network (Utility)
- Home Automation Network (Home Owner)





### Home Automation

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- Smart Energy Network (Utility)
- Home Automation Network (Home Owner)
- Dual PAN
  - Smart Energy & Home Automation





Home Automation



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## Features and Benefits

Features		Benefits			
R	=				
•	Class-leading link budget	• 112 dB link budget provides greater range, reducing the need for external power amplifiers and lowering cost.			
•	Low power consumption	<ul> <li>17mA TX / 19 mA RX power consumption extends battery life</li> </ul>			
•	Dual PAN support	• System can actively participate in 2 networks, eliminating the need for multiple radios.			
•	Diversity Support	• Freescale's FAD (Fast Antenna Diversity) allows the hardware to automatically select between 2 antennas, improving reliability in high interference environments.			





Features	Benefits			
MCU				
• ARM <sup>®</sup> Cortex <sup>™</sup> -M4 core with DSP	Up to 50 Mhz core provides a broad range of application support			
<ul> <li>Up to 512 KB of Flash and 64 KB of RAM</li> </ul>	• Provides enough memory to run complicated protocols or dual stacks and user applications on a single IC			
• 256 KB of FlexMemory (MKW21 only)	Allows user to define configuration of memory between     Flash and EEPROM			
Secure Flash	Protects the code and data from unauthorized access or modification			
Tamper detect	<ul> <li>Protects critical IP by detecting tamper events (NDA required)</li> </ul>			
Cryptography Acceleration Unit	Reduces code size and execution time through hardware support for advanced security protocols			
• 128-bit Random Number Generator	Meets the FIPS 140 Security Requirements for Cryptographic Modules			





### **MKW2x Enablement**

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## KW2x Development Kit

**Kit Features** 

- Can use PCB "F" antenna or bypass for external antenna via RF connector
- Open-SDA debugging
- USB port to interface with PC
- Configurable I/O access
- LEDs and switches for demonstration, monitoring and control
- BeeKit Tool with stacks and applications
  - ZigBeePro R20 with SE 1.1.x, HA 1.1, HC 1.0 profiles
  - Simple MAC and RF Test Tool
  - Dual-PAN example
  - Over-The-Air programming example
  - Coming: ZigBeeIP and SE 2.0 profile
- Quick Start Guide

#### **Tower Form Factor**

- · Use standalone or in Tower System
- · Boards sold individually
- Combine as many boards as needed



Part Numbers:

TWR-KW21D256 TWR-KW24D512









### **802.15.4 Protocol Stack Comparison**

Feature	SMAC	802.15.4 MAC	SynkroRF®	ZigBee® RF4CE	ZigBee® Pro	ZigBee® IP
Applications						
Cable Replacement	$\checkmark$	✓	✓		$\checkmark$	
Remote Control	$\checkmark$	✓	$\checkmark$	$\checkmark$	$\checkmark$	
Home Control			✓	✓	✓	
Home Automation					✓	
Health Care					✓	
Building Automation						
Smart Energy					✓	✓
Network Stack	No	No	Yes	Yes	Yes	Yes
Application Profiles	No	No	No	Yes	Yes	Yes
Memory Requirements	4-8K	32K	<40K	<40K	128-160K	256K
Network	Point-to- Point	Peer-to-Peer	Co-existing Star	Co-existing Star	Tree	Mesh
ropology	Star	Tree			Mesh	
Typical # of Nodes	2-100	2-1000	32 per Controlled Device	32 per Target Device	2-1000 ZigBee Pro	2-32
Typical Data Throughput	50-115K	90-115K	70-100K	70-100K	30-70K	<50K



## **Freescale BeeKit Toolchain**



#### Compiler/Debugger 2nd stage IDE OOB Demos, Commissioning, Testing







Presecute, the Presecute logs, AdVec, C.S. Code/EB7, Code/Aurice, CutoFire+, C.Mare, Inv Energy Ethiler: Solutions legs, Xineta, mobile/31, PSG, PowerQUCC, Processor Expert, ColfD, Garana, EsteAssaw, the SateAssaw logs, StaCore, Symptony and Vortilia are trailerated of Freetoate Interconductor, to:, Reg. U.S. Par, 87th. Off. Antan, Swith, BeeStack, CareNet, Pans, Layersage, MagnY, MPC, Parlors in a Participe, Gord Gorwege, GUDC Engine, Ready Play, SWITHOS, Treve, Turboluk, Vytrid and Threads an Enderrooks of Freedom Germonductor, Inc. All other product or solvice regress are the property of their respective element. O 2011 Freedom Germonductor, Inc.