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Low Power Embedded Controllers

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- Flexis QE Family
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The Energy Efficient Solutions Mark

Technology Expertise
Freescale's technology expertise in delivering product solutions optimized for high performance within constrained energy or power budgets

Best-in-Class Product Solutions
Freescale product solutions whose implementation of energy or power management technologies and/or performance within a specified energy budget over the life of the application is truly optimal and/or best-in-class.

Assurance for Application Needs
Offers customers added assurance of the right combination of technologies and techniques to achieve optimal energy savings for a particular application space.

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The Importance of Low Power

Longer battery life	Reduced operating costs / end product differentiation
Reduced heat dissipation	Removes cost of heat sinks / fans
Reduced system complexity	Faster development / time-to-market
Ability to meet more low power standards	Larger target market
Increased reliability for battery back-up critical applications	End product differentiation
Increased board density	Increased system performance

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Freescale's Low Power Strategy

•Develop industry leading low power technology that delivers enhanced battery life performance for embedded applications

•Embed low power IP across the 8-bit S08, 16-bit Digital Signal Controller, & 32-bit ColdFire architectures offering performance & price scalability for low power applications

•Develop a broad portfolio of general purpose & market specific product families that combine low power IP with LCD, Ethernet, USB, and Motor Control functionality

•Provide an extensive development ecosystem including reference designs, application notes, and training resources (like this seminar!) to promote the awareness of low power design techniques and reduce product time to market

Energy Efficient Solutions™
optimized for low power

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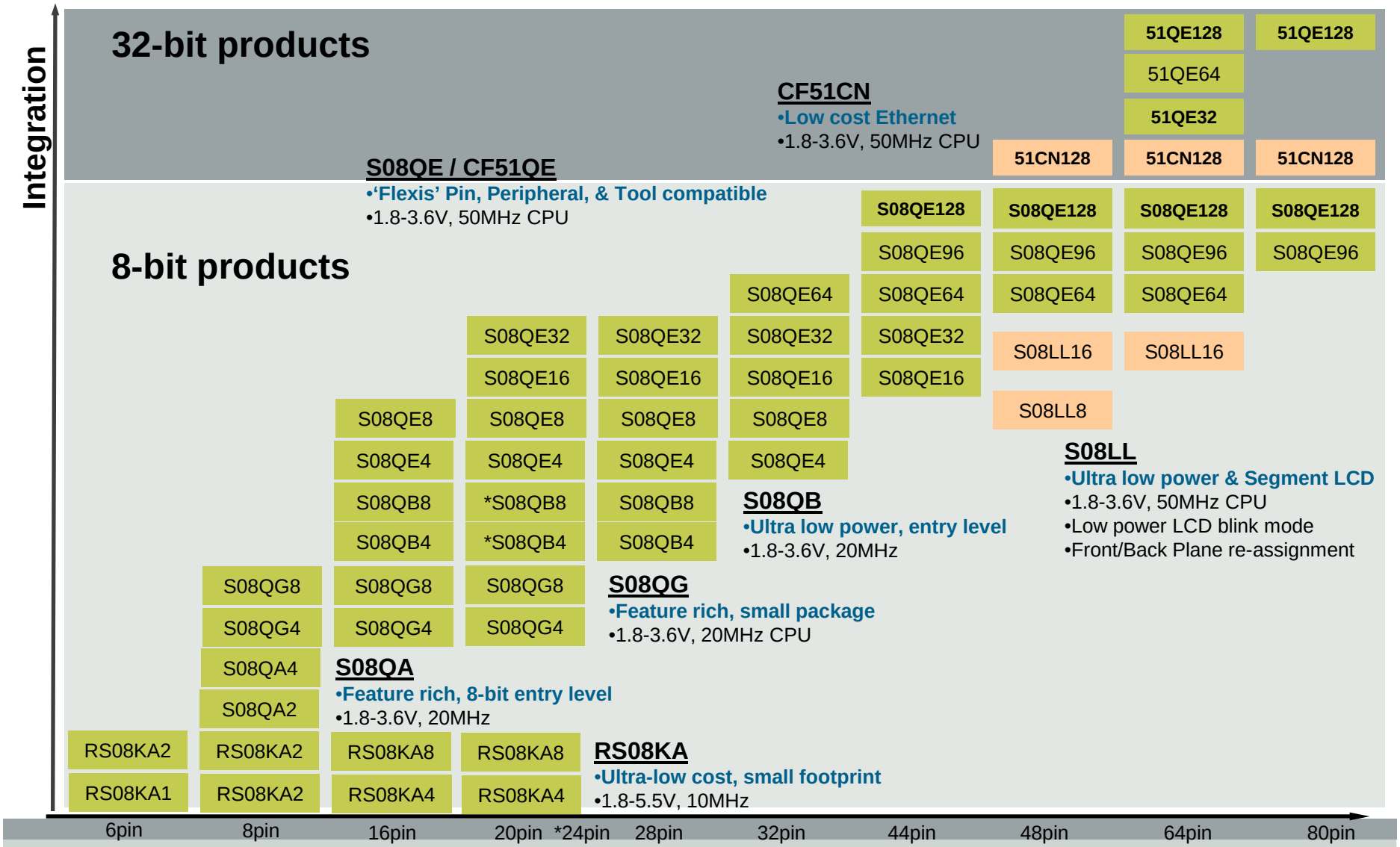
Available | New | In Design

Low Power MCU Roadmap



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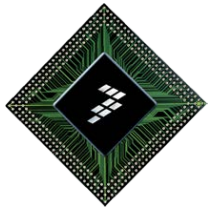
Flexis QE Family



MSG Product Marketing
Industrial & Multi-Market

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What is the Flexis™ Family of Microcontrollers?

1. Single development tool
   - 8-bit (S08) and 32-bit (CFV1)
2. Common peripheral set
   - Allows software reuse between 8-bit and 32-bits
3. Pin to Pin compatibility
   - Maximize hardware reuse when moving between 8-bit and 32-bit

✓**Multiple configurations / performance levels with a single h/ware design**

✓**Software re-investment and design cycle time drastically reduced**

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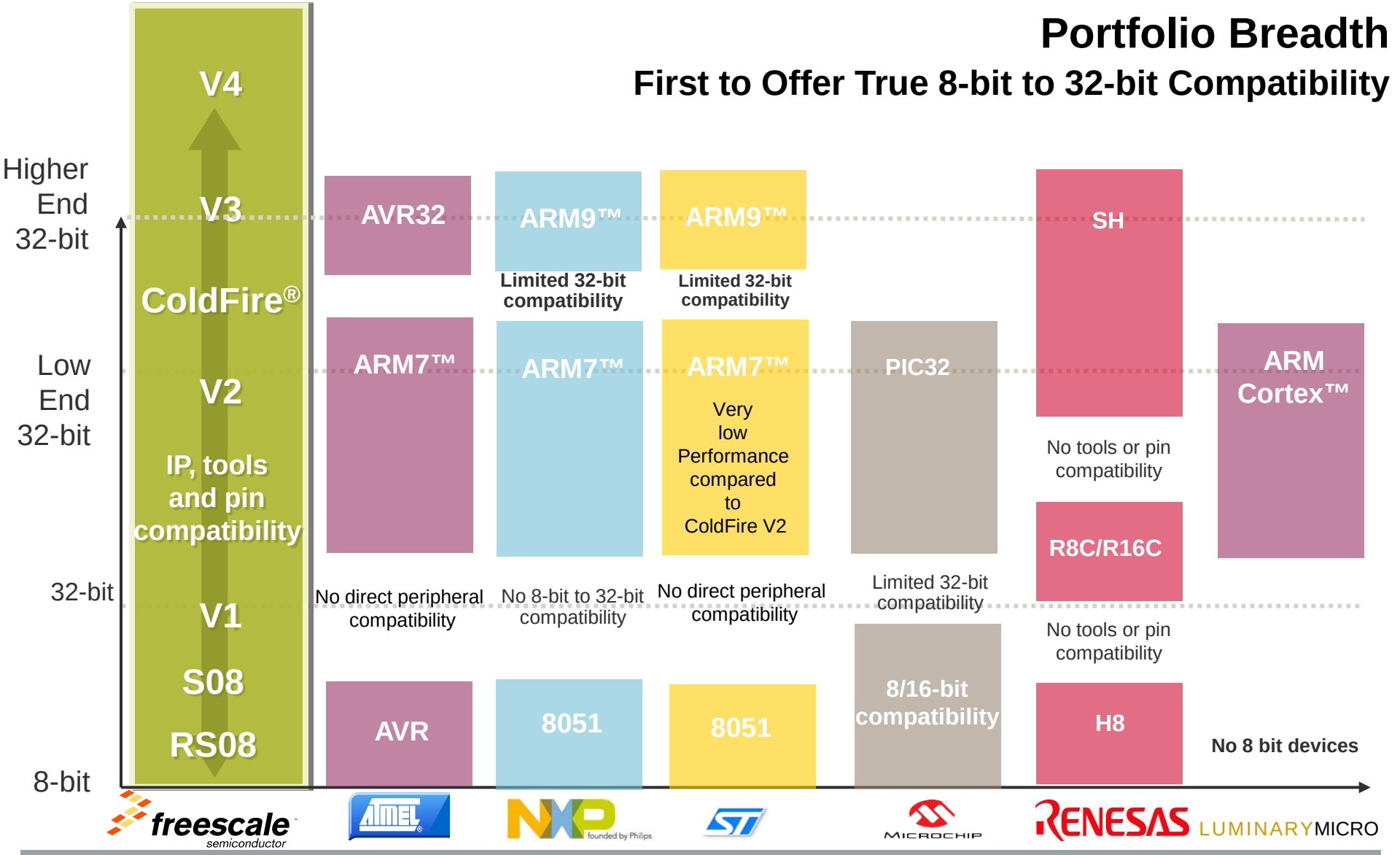
Portfolio Breadth

First to Offer True 8-bit to 32-bit Compatibility



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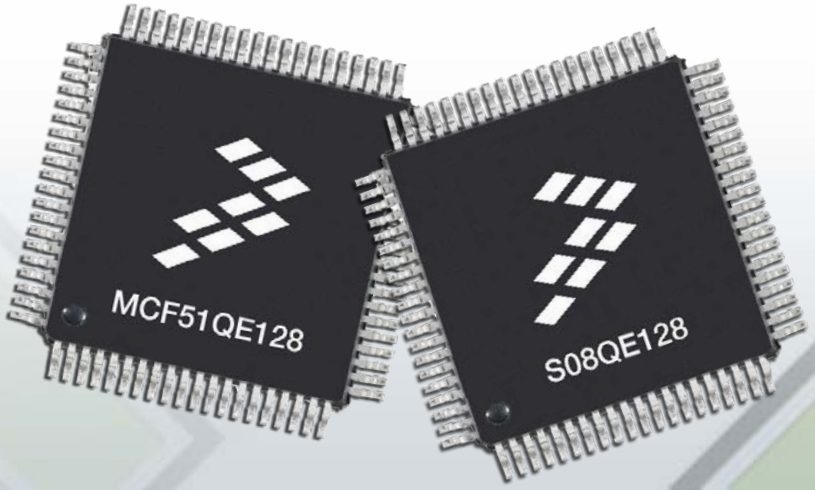
QE128 family—an industry leader in ultra-low power

- Optimized architecture enables better power efficiency to extend battery life
- Market leader in comparable 8-bit and 32-bit devices in run current in low power run mode
- Flexibility to choose a combination of low power and high performance options



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Expanding the Flexis QE Key Messages

Unprecedented compatibility	Ultra-low power	Easy to use
Freescale's Controller Continuum provides unique flexibility to transition between 8-bit and 32-bit. With pin, peripheral and tool compatibility, the Flexis™ QE device duo simplifies and speeds the design process.	Through an optimized architecture that provides lower operating voltage and current, the QE devices offer industry-leading ultra-low-power benefits to extend battery life.	Common CodeWarrior development tools, training and documentation gets you on the design fast track. Pin and peripheral compatibility avoids learning new codes and tools.
With the Flexis series of controllers, Freescale provides unprecedented compatibility between 8- and 32-bit microcontrollers.	A new, optimized architecture enables better power efficiency to help extend battery life.	New CodeWarrior software with Processor Expert eases and speeds the design process for both 8/32-bit.
The QE128 device duo is pin, peripheral and tool compatible providing a single migration path from 8-bit to 32-bit.	The S08QE128 beats market leader TI's comparable devices by offering lower run current in our low power run mode.	Pin and peripheral compatibility avoids learning new codes and tools.
The Freescale Controller Continuum allows customers to design for a wide range of products – from the low end to the high end.	The MCF51QE128 is among the most efficient 32-bit MCUs in the industry with an excellent mA/MIP rating.	The MCF51QE128 uses 8-bit peripherals to provide 32-bit performance with 8-bit ease of use.
Stepwise compatibility allows for scalability within Freescale's broad MCU portfolio (RS08→S08→ColdFire).	Combination of low power and high performance offers unique flexibility to turn peripheral clocks on and off to use only the current you need.	A full support and training ecosystem of reference designs, application notes, virtual labs and webcasts help customers get started quickly.

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Flexis QE: Overview

50MHz S08 or ColdFire V1 core
25MHz bus frequency
1.8-3.6V operating range

Memory

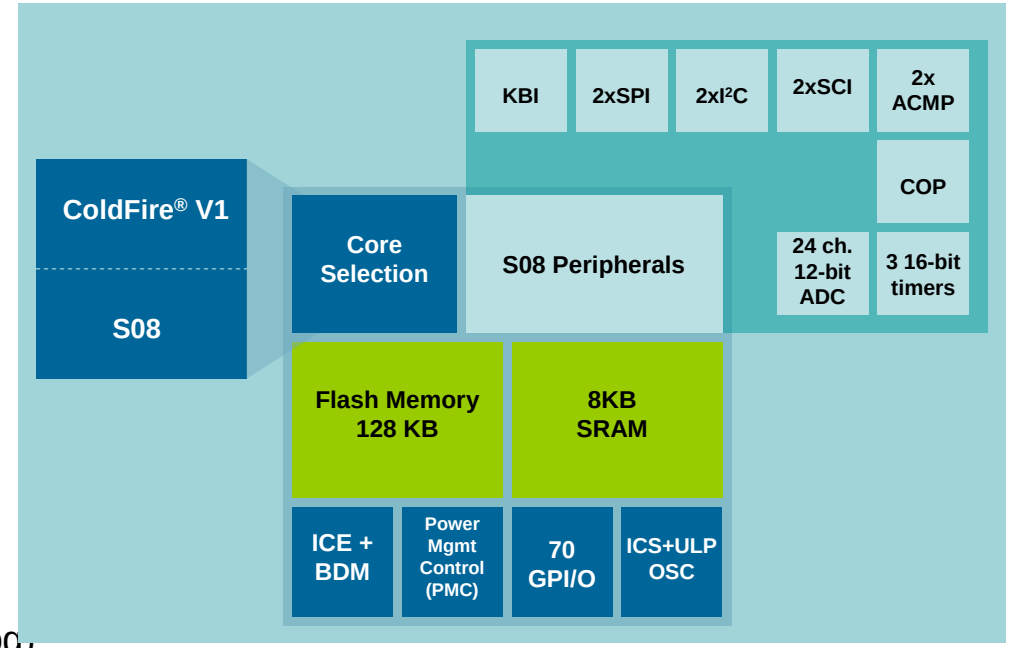
- Up to 8K bytes SRAM
- Up to 128K bytes flash

Features

- 2x SCI, 2x I2C, 2x SPI
- 2x KBI – 8 channels each
- 16-bit timers: 1 x 6-ch, 2 x 3-ch
- 12-bit 24 channel A-to-D converter
- 2 analog comparators
- Up to 70 general purpose I/O
- System integration (PLL, SW Watchdog)
- Integrated 1-pin BDM interface
- Rapid I/O

Ultra-Low Power

- Internal Clock Source (ICS)
- Vreg with fast start up and low regulation voltage
- Low power 32 kHz oscillator
- Optimize clock tree and clock gating techniques



S08QE Packages

80LQFP, 64LQFP, 48QFN, 44QFP, 32LQFP

ColdFire QE Packages

80LQFP, 64LQFP

Temperature Range

-40C to 85C

10K Pricing from

S08QE128: $2.42 and ColdFire V1QE128: $2.78
S08QE64: $2.13 and ColdFire V1QE64: $2.88

**Price varies by package*

MC9S08QE32/16

Features / Benefits
- Internal clock source (ICS)
- Vreg w/ fast start-up time and low-regulation voltage
- Ultra- Low power 32 kHz oscillator (standby current 1 uA)
- Optimized clock tree and clock gating techniques

Supply Voltage / Performance
- 1.8 – 3.6 V operation
- -40 to 85 C operation

Core
- 50.33 MHz HCS08 core
- 25.165 MHz bus frequency

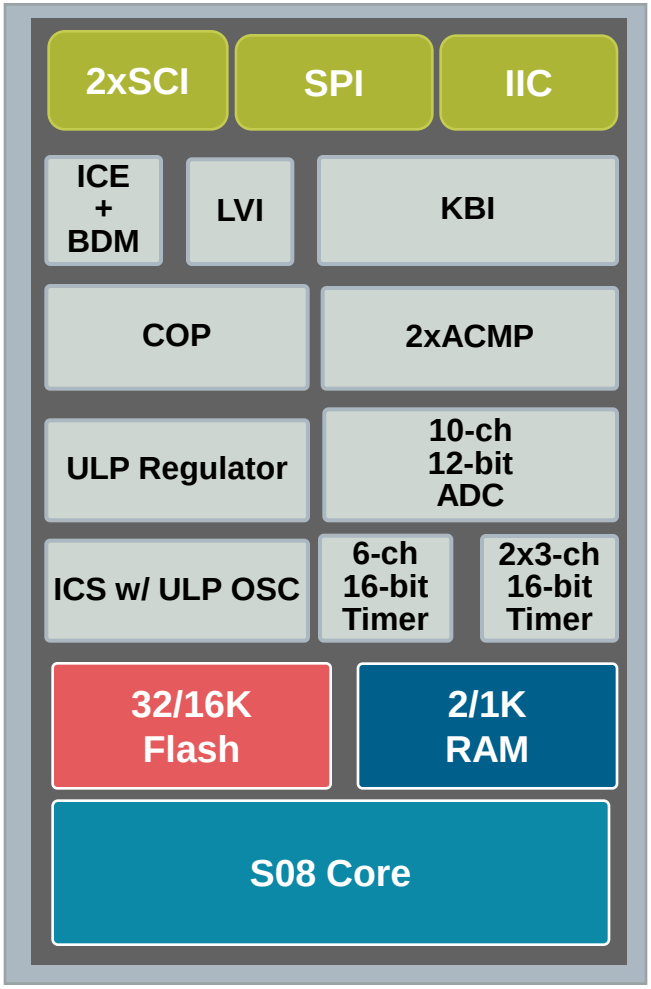
Memory
- Up to 32K Flash, Up to 2K RAM

Communications
- 2xSCI, SPI, IIC w/ broadcast mode

Packages
- 48QFN, 44LQFP, 32LQFP, 28SOIC

Pricing
- QE32/16 starting at $1.49* for 10K units MSRP

***Varies by package**



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MC9S08QE8/4

Features / Benefits

- Internal clock source (ICS)
- Vreg w/ fast start-up time and low-regulation voltage
- run off of an ultra-low-power 32kHz oscillator that consumes less than 1.0 µA of current
- Optimized clock tree and clock gating techniques

Supply Voltage / Performance

- 1.8 – 3.3 V operation
- -40 to 85 C operation

Core

- 20 MHz HCS08 core
- 10 MHz bus frequency

Memory

- 8K Flash, 512B RAM

Communications

- SCI, SPI, IIC w/ broadcast mode

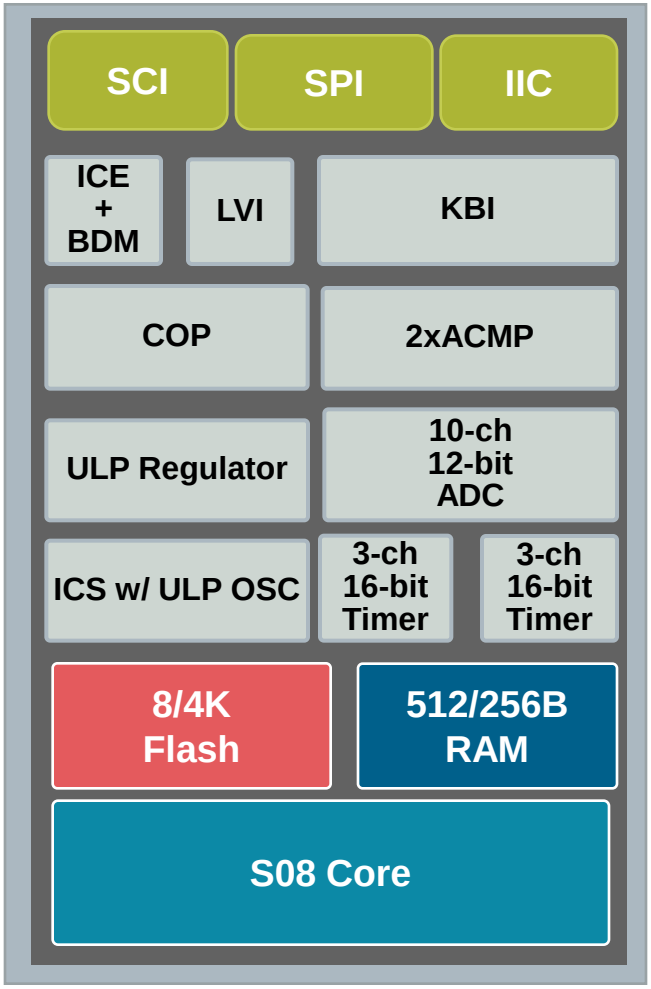
Packages

- 16 TSSOP, 16 PDIP, 20 SOIC, 28 SOIC, 32 LQFP

QE8 Pricing

- $1.15* MSRP at 10K units

***Varies by package**



Last updated September 5, 2007

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Enhanced Product Specifications: STOP Idd (S08QB4/8, S08QE4/8, S08QE16/32)

S08QE8							S08QE32						
		V	typ	max		temp			V	typ	max		temp
P	Stop 2	3	0.3	0.65	uA	-40 to 25	P	Stop 2	3	0.35	0.65	uA	-40 to 25
C			0.5	0.8		70	C			0.8	1		70
P			1	2.5		85	P			2	4.5		85
C		2	0.25	0.5	uA	-40 to 25	C		2	0.25	0.5	uA	-40 to 25
C			0.3	0.6		70	C			0.75	0.85		70
C			0.7	2		85	C			1.5	3.5		85
P	Stop 3	3	0.4	0.8	uA	-40 to 25	P	Stop 3	3	0.45	1	uA	-40 to 25
C			1	1.8		70	C			1.5	2.3		70
P			3	6		85	P			4	8		85
C		2	0.35	0.6	uA	-40 to 25	C		2	0.35	0.7	uA	-40 to 25
C			0.8	1.5		70	C			1	2		70
C			2.5	5.5		85	C			3.5	6		85

- Changes have been made to the S08QB & Flexis QE family product specifications to include power consumption ratings @ 40to25°C and @ 70 C. **Note: S08LL8/16 documentation will be updated with this information by mid Mar09**
- Stop Idd grows exponentially with temperature - **70°C rating is significantly lower than 85°C rating** – good for applications that don't require 85°C
- Parameters are characterized by design [C] and production tested [P]. Parameters that are production tested are checked on every device before it is shipped
- Typical values: the value that most parts will achieve
- Maximum values: the Limit (usually set in production testing) that parts will achieve

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Enhanced Product Specifications: STOP Idd (S08QE64/128 & CF51QE32/64/128)

S08QE128							51QE128 - O'Douls						
		V	typ	max		temp			V	typ	max		temp
P	Stop 2	3	0.35	0.6	uA	-40 to 25	P	Stop 2	3	0.6	0.8	uA	-40 to 25
C			0.98	2		70	C		3	3.0	11		70
P			2.5	7.5		85	P		3	8.0	20		85
C		2	0.25	0.5	uA	-40 to 25	C		2	0.6	0.8	uA	-40 to 25
C			1.4	1.9		70	C		2	2.5	10		70
C			1.91	6.5		85	C		2	6.0	12		85
P	Stop 3	3	0.45	1	uA	-40 to 25	P	Stop 3	3	0.8	1.3	uA	-40 to 25
C			1.99	4.2		70	C		3	6.0	18		70
P			5	15		85	P		3	18.0	28		85
C		2	0.35	0.7	uA	-40 to 25	C		2	0.8	1.3	uA	-40 to 25
C			2.9	3.9		70	C		2	5.0	16		70
C			3.77	13.2		85	C		2	12.0	20		85

- Changes have been made to the Flexis QE family product specifications to include power consumption ratings @ 40to25°C and @ 70 C
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- Typical values: the value that most parts will achieve
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Enhanced Product Specifications: Current consumption of additional modules active during STOP mode

New specification (shown for 9S08QE8):

Num	C	Parameter	Condition	Temperature				Units
				–40°C	25°C	70°C	85°C	
1	T	LPO	—	50	75	100	150	nA
2	T	ERREFSTEN	RANGE = HGO = 0	1000	1000	1100	1500	nA
3	T	IREFSTEN[1]	—	63	70	77	81	µA
4	T	RTC	Does not include clock source current	50	75	100	150	nA
5	T	LVD[1]	LVDSE = 1	90	100	110	115	µA
6	T	ACMP[1]	Not using the bandgap (BGBE = 0)	18	20	22	23	µA
7	T	ADC[1]	ADLPC = ADLSMP = 1 Not using the bandgap (BGBE = 0)	95	106	114	120	µA

Electrical specifications updated to include current-consumption data at 4 different temperatures (-40°C, 25°C, 70°C and 85°C), allowing a precise estimation of Battery-life

These new specifications are already implemented in datasheets for S08QE- & QB- families.

Note: S08LL8/16 documentation will be updated with this information by mid Mar09

Enhanced Product Specifications: Leakage Current

Old specification (here 9S08QE8):

Num	C	Characteristic		Symbol	Condition	Min.	Typical[1]	Max.	Unit
9	P	Input leakage current	all input only pins (Per pin)	$\|I_{In}\|$	$V_{In} = V_{DD}$ or V_{SS}	—	—	1	µA
10	P	Hi-Z (off-state) leakage current	all input/output (per pin)	$\|I_{OZ}\|$	$V_{In} = V_{DD}$ or V_{SS}	—	—	1	µA

Action Plan:

- S08LL8/16 evaluation completed (20K devices)
- Some pins are leakier than others (dependant on internal pullups/pulldowns)
  - Worst case leakage-currents of 9S08LL16:
    - Worst-case pin/port is ptc6 with measured 66nA average
    - Leakage on the LCD-pins are measured worst case 45nA vs. Vdd (<3nA vs GND)
    - All Other Port-pins are worst case 29nA average vs. Vdd (<3nA vs GND)
- Next phase will feature the re-specification of the Maximum Values for leakage-current 9-Sigma (due Q209). The specification will be extended to differentiate between leakier and less leaky pins, allowing customers to optimize battery life
- **New leakage-current specification to be applied to all Flexis QE & S08QB product families**

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Enhanced Low Power Product Specifications: Summary

New Stop-Idd-specifications alread updated in the following datasheets:

9S08QE/QB-Family (no LCD):

- 9S08QE4/8: http://www.freescale.com/files/microcontrollers/doc/data_sheet/MC9S08QE8.pdf
- 9S08QE16/32: http://www.freescale.com/files/microcontrollers/doc/data_sheet/MC9S08QE32.pdf
- 9S08QE64/96/128: http://www.freescale.com/files/microcontrollers/doc/data_sheet/MC9S08QE128.pdf
- 9S08QB4/8: http://www.freescale.com/files/microcontrollers/doc/data_sheet/MC9S08QB8.pdf

New Stop-Idd-specifications will be implemented shortly (Mar09) on:

9S08LL-Family (with LCD):

- 9S08LL8/16: http://www.freescale.com/files/microcontrollers/doc/data_sheet/MC9S08LL16.pdf

Leakage-currents on our 9S08QE/QB/LL are much better than specified.

Action Plan in place for re-specification (due mid'09; see previous slide)

Future low power products to be specified in the same way

Ultra-Low Power Overview

Ultra-low-power run and wait modes
- CPU and peripherals run with voltage regulator in low power mode
- Allows full functionality at reduced frequency for lower power operation

Clock gating
- Turn clocks off to unused peripherals
- Reduces overall run and wait mode current

Ultra-low-power internal regulator & oscillator
- Fast Start Up from stop modes, typically 6-7 usec
- New low power external oscillator consumes less than 1 uA

Ultra-low-power internal clock source & oscillator
- Eliminates need for external clock source
- Supports low frequency operations which lowers power in system

Ultra-low-power real-time counter
- Use in run, wait and stop modes
- Use with low power oscillator, internal or external clock sources

	MCF51QE128	MC9S08QE128
Run Mode @ 2 MHz CPU / 1 MHz bus	2 mA	1 mA
Run Mode @ 50 MHz CPU / 25 MHz bus	27 mA	11 mA
Lower Power Run Mode @ 32 kHz CPU/16 kHz bus	50 uA	22 uA
Stop 2 – Lowest power mode; partial power down of circuits	370 nA	370 nA
Stop 3 - Int. circuits loosely regulated; clocks at low frequency	520nA	450 nA
Stop 3 - Wake Up Time	6 us	6 us

Preliminary typical measurements, Vdd = 3V, Temp = 25C

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High Performance *and* Low Power

QE128 devices can run at 50 MHz CPU frequency down to 2.4V, 40MHz from 2.4V to 2.1V

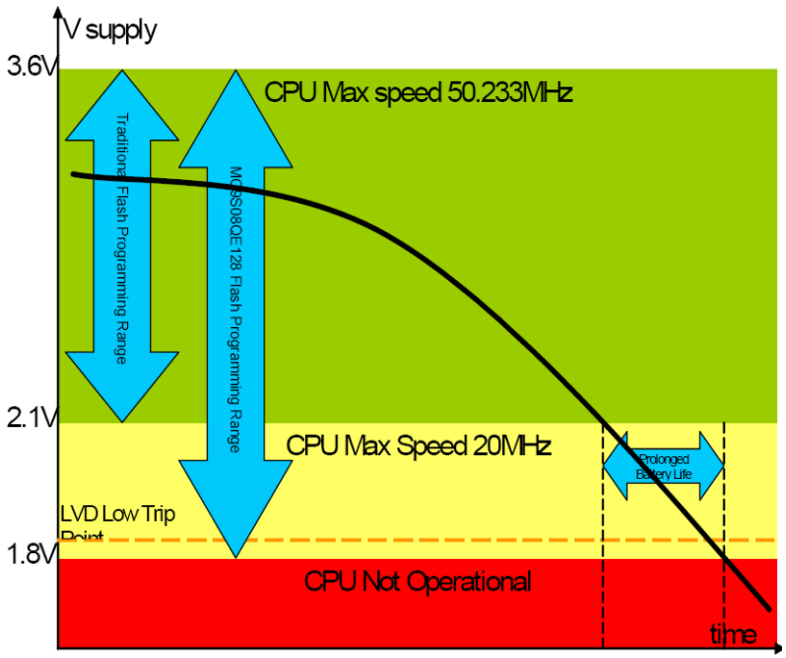
- Configure peripherals in microseconds
- Copy/search large data tables rapidly
- Perform complex calculations faster

Below 2.1V, QE128's can still run at 20 MHz CPU frequency

- Flexis devices are designed to run at high frequency across all voltages

Flash programming at 1.8V while typical competitors' lowest is 2.2V

- If working off batteries, with FSL part customer can re-program flash
- Ability to update variables/constants and provides greater flexibility
  - Can save variables to flash before batteries die and are replaced
  - Can perform field s/w upgrades at any time, doesn't require fresh batteries



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Which Device and When?

Use MC9S08QE128 when:	Use *both* S08 and ColdFire QE128 when:	Use MCF51QE128 when:
• Absolute minimum power consumption required • Low pin count options desired (48 QFN, 44 QFP, 32 LQFP) • No application requirement for higher performance calculations or peripherals • Greater cost sensitivity • Small memory options may be required (S08QE32/16/8/4) and/or small footprint packages (from 16pin) • Increased code space (128kB) required for enabling more functionality in an 8-bit footprint	• Designing for a portfolio of products of varying performance and price options • Code portability is required across all the product portfolio (low end to high end) • Limited design resources to maximizes the return on invest	• Immediate or near-term requirement for higher mathematical processing performance • Interested in achieving low-cost and low-overhead link into 32-bit designs • Flash densities (>128KB) may be required • Immediate or near-term requirement for faster-communication throughput (Serial, CAN, Ethernet or USB)

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Low Power Example using the ColdFire V1 QE128

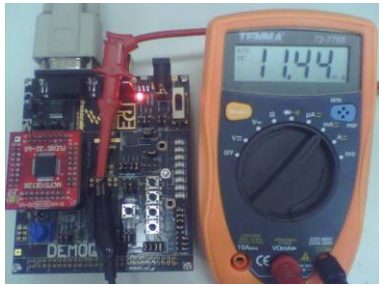
Setting the Stage

- CodeWarrior for Microcontrollers
- DEMOQE128 Demonstration Board
- MCF51QE128 Device (ColdFire V1 microcontroller)
- Clock Gating and Peripherals on/off

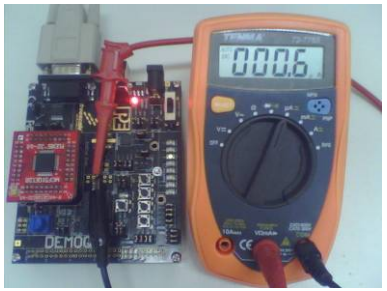
- Showing instantaneous current measurements (every 5 second intervals)
- Applications/systems needing periodic task wake-up/back to sleep (sending not necessary at all times)
  - Examples: Irrigation systems, sprinkler systems or home networks (with sensors)

What are the results?

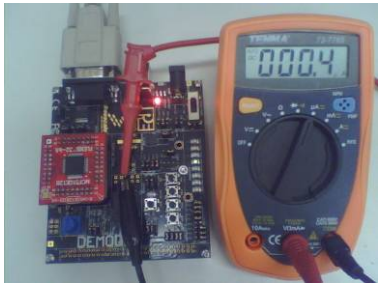
Ultra-Low Power



8MHz Run Measured Current: 11.44uA



Stop 3 Measured Current: 0.6uA



Stop 2 Measured Current: 0.4uA

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Target Applications

Medical Instrumentation

- Portable health monitors
- Home health monitoring
- Patient monitoring
- Dialysis machines
- Cardiac rhythm management
- Hearing analysis equipment
- Powered beds
- Infusion pumps
- Electric wheelchairs
- Laboratory equipment

Point of Sale

- Card payment terminals
- Handheld bar code scanners
- Stationary bar code scanners
- Bar code printers
- Automatic Teller Machines (ATMs)
- Portable data collection terminals

Factory Automation

- Motion controllers
- Machine vision
- Operator panels
- Embedded computer boards
- I/O modules
- Industrial networking products
- Process controllers
- Measurement equipment

Fire/Security

- Smoke/heat detectors
- Fire alarm sounders and control panels
- CCTV cameras and control panels
- Security cameras
- Intruder alarm control panels
- Intruder alarm motion detectors
- Access control
- Biometrics security systems
- Carbon dioxide detectors

Consumer

- Invisible pet fences
- Electronic toys
- Electronic keys and locks
- Thermostats
- Remote controls
- Cordless telephones
- Digital cameras/camcorders
- Personal care products (electric shavers, toothbrushes, etc.)

HVAC and Building Control

- Utility meters
- Environmental & building automation
- Gas boiler controls
- Thermostats
- Utility meters
- Lamp ballast
- Air conditioners

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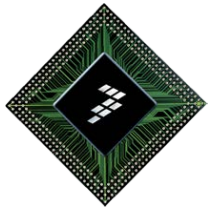
S08LL16/8, RS08LA8, RS08LE4



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Introducing the L Family

Introducing a trio of 8-bit MCU families (S08LL, RS08LA, RS08LE) with industry-leading LCD capabilities, including the ability to drive more segments with fewer pins (up to 8x mode). In addition, the S08LL family offers best-in-class, ultra-low-power performance.

Integrated LCD Driver

High segment on-chip LCD driver module is software-configurable and eliminates the need for separate display driver chip, reducing board space and total system cost.

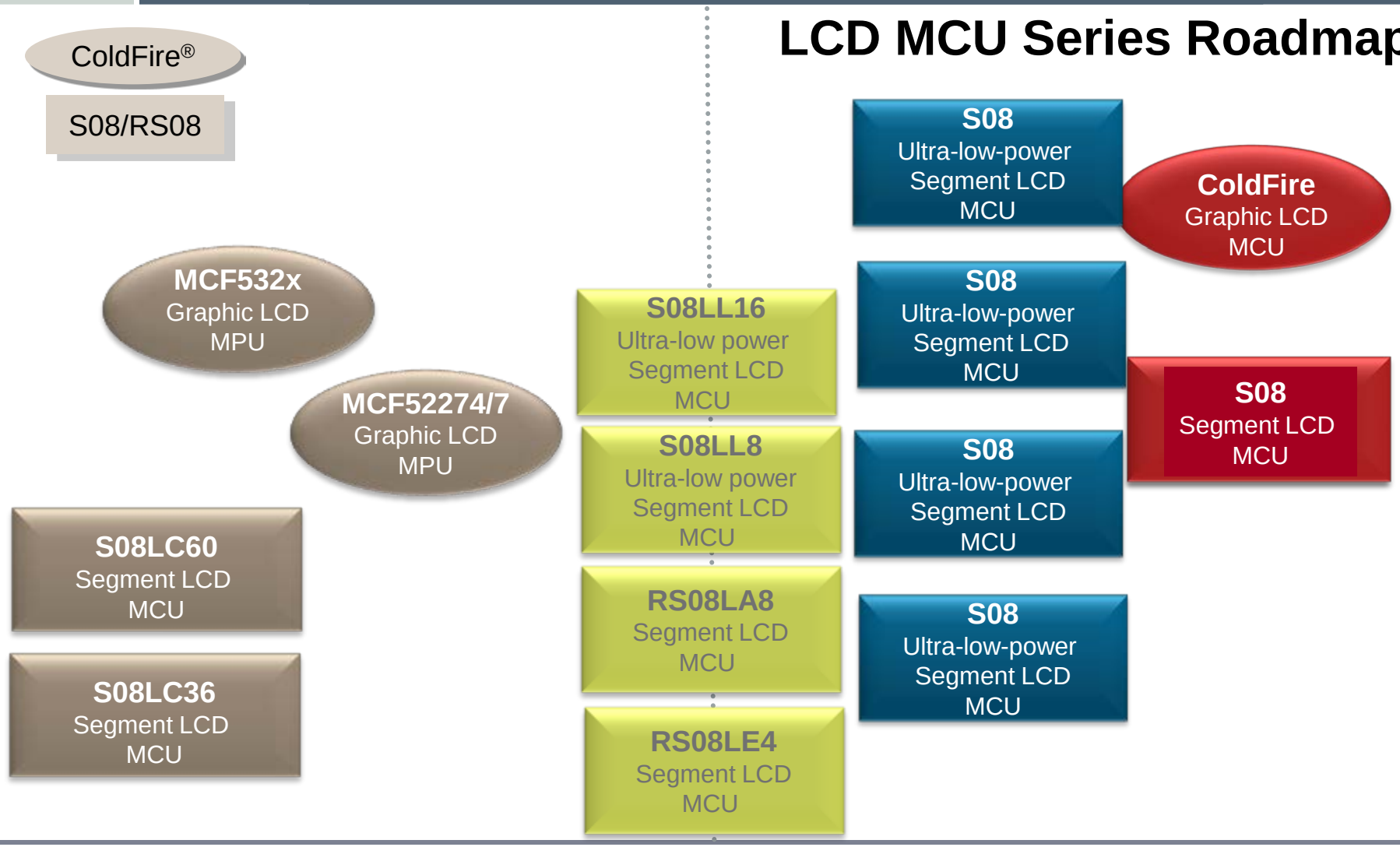
Flexible Pin Functionality

- With L family MCUs, developers can drive more segments with fewer pins, enabling smaller connectors and smaller footprint. Different functionality can be assigned to pins, enhancing design flexibility

Ultra-Low Power

- Developers can choose from a wide range of products within the family to optimize their designs for power-conscious, cost-sensitive applications.

LCD MCU Series Roadmap



Roadmap designates planned devices.

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New Segment LCD Solutions

Segment LCD Solutions	Key Features & Benefits
S08LL16/8	• The LL16/8 offers Freescale's ultra-low-power technology at 1.8V with winning features, such as 20MHz CPU, flash reprogramming and ADC accuracy. Intended for low-power and portable applications, such as thermostats and blood glucose meters.
9RS08LA8	• The LA8 is a cost-effective MCU that features 6-channel 10-bit ADC, analog comparator, internal charge pump and internal oscillator.
9RS08LE4	• The LE4 has the RS08 core, which provides 8-channel 10-bit ADC in 28-pin SOIC package options for small appliances and meters.
Common Features	• LCD features can drive large segment (8x mode) LCDs with fewer pins. FP or BP reassignment simplifies PCB layout and provides the opportunity to optimize designs for EMI performance.

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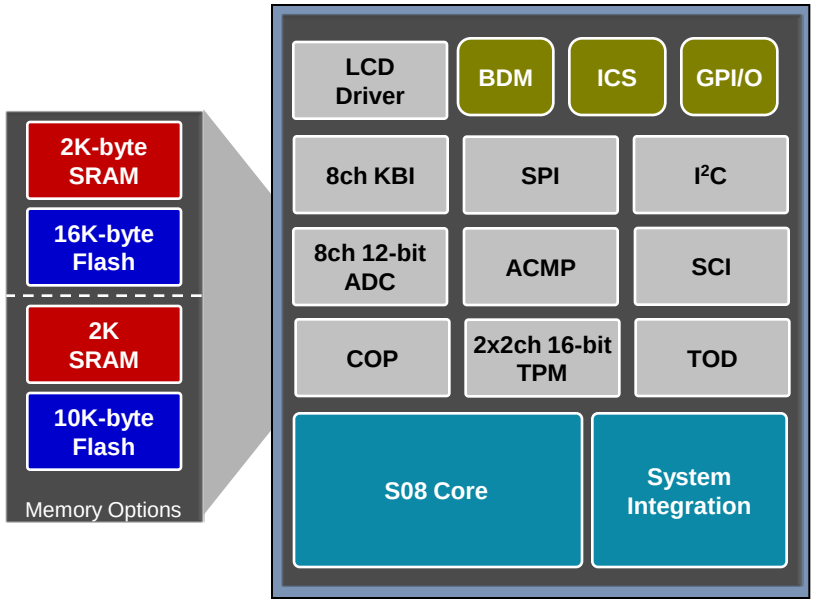
MC9S08LL16 – Ultra Low Power with Segment LCD

Introducing the 8-bit MCU LL family with industry-leading LCD capabilities, including the ability to drive more segments with fewer pins (up to 8x mode). In addition, it offers best-in-class, ultra-low-power performance.

S08 Core

- Up to 20M CPU
- Temperature range of -40°C to 85°C, 1.8-3.6V Op Range
- **On-Chip Memory**
  - FLASH read/program/erase over full operating voltage and temperature
  - 2K Random-access memory (RAM)
  - Flash size
    LL16: 16K-byte, 8K in Flash A, 8K in Flash B
    LL8: 10K-byte, 8K in Flash A, 2K in Flash B
- **Clock Source Options**
  - Oscillator (XOSC) — Loop-control Pierce oscillator; Crystal or ceramic resonator range of 31.25 kHz to 38.4 kHz or 1 MHz to 16 MHz
  - Internal Clock Source (ICS) — Internal clock source module containing an FLL controlled by internal or external reference; supports bus frequencies up to 10 MHz
- **System Protection**
  - Watchdog computer operating properly (COP) reset
  - Low-voltage detection with reset or interrupt
  - Illegal opcode detection with reset
  - FLASH block protect
- **Single Wire Background Debug Interface**



- **Power-Saving Modes**
  - 2 very low power stop modes
  - Reduced power wait mode
  - Low power run and wait modes allow peripherals to run while voltage regulator is in standby
  - Very low power external oscillator that can be used in stop2 or stop3 modes to provide accurate clock source
  - 6 usec typical wake up time
  - Peripheral clock gating

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MC9S08LL16: Low Power Features

Power Saving modes

- 2 very low power stop modes
- Reduced power wait mode
- Low power run and wait modes allow peripherals to run while voltage regulator is in standby
- 6 usec typical wake up time

Low Power LCD Module

- Low power LCD waveform
- Multi LCD power supply configuration
- Efficient internal charge pump to produce LCD bias voltages
- LCD display and blink in Low Power mode

Low Power Oscillator

- Very low power external oscillator that can be used in stop2 or stop3 modes to provide accurate clock source in LP mode

Others

- TOD for low power time keeping
- Clock gating

Low Power LCD IP

Challenge	Freescale Solution
Too many pins required to drive many segments. Typical:	Fewer pins to drive the same number of segments and also supports 4x by mode
52 pins for 192 segments in 4x48 mode 44 pins for 160 segments in 4x40 mode 29 pins for 100 segments in 4x25 mode	32 pins for 192 segments in 8x24 mode 28 pins for 160 segments in 8x20 mode 17 pins for 104 segments in 8x13 mode
Blinking mode takes power and resources	Low resource low-power blinking mode
Blink mode activated by setting a bit in a register however MCU must exit STOP mode, execute code and then go back to SLEEP in every blinking period => power consumption!	Blink mode does not require the MCU to wake up – can be active when MCU is in SLEEP mode and segments will blink at pre-set frequency Alternate display feature - display alternate data (e.g. blink temperature and time)
Layout is very complex because the front planes (FPs) and backplanes (BPs) are fixed in pin-outs	FP and BP re-assignment capability
FP and BP typically distributed along all sides of MCU – special component placement / PCB layout required to minimise tracks between the MCU and LCD to reduce EMI – time consuming & costly	FP & BP are software selectable to be either FP or BP – makes PCB layout easier and more flexible
LCD glass requires multiple voltages and voltage divider resistor ladders which consume too much power	Internal charge pump provides all voltages required to power up LCD glass
Battery voltage drops over time producing LCD degradation due to lack of optimum voltage levels	Internal s/ware selectable regulated power supply provides constant voltage across LCD – no degradation.

S08LL Development Tools

Get started with segment LCD solutions—freescale.com/8bit

- Documentation
- CodeWarrior Development Studio for Microcontrollers 6.x
- DEMOS08LL16 demo board ***$69***
- DEMO9RS08LA8 demo board ***$59***
- DEMO9RS08LE4 demo board ***$59***

Training and support—freescale.com/LCD

- Reference designs
- Migration application notes
- See a demonstration

Online courses—freescale.com/training

- RS08
- HCS08

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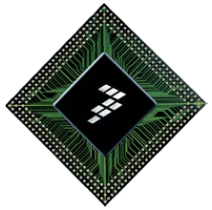
Other Low Power NPI



MSG Product Marketing
Industrial & Multi-Market

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MC9S08QA4/2

HCS08 Core
- S08 8-bit CPU @ 20MHz
- Voltage range 1.8v to 3.3v
- Operating temp. -40C to +85C
- 5 GPIOs and one output only pin

Memory
- QA4: 4K Flash, 256 Bytes RAM
- QA2: 2K Flash, 160 Bytes RAM

Clock
- Internal Clock Source (ICS)
  - 10Mhz Bus
  - FLL
  - On chip oscillator
  - External crystal support
  - 2% accuracy over full operating range

Peripherals
- 4-channel, 10-bit ADC
- One ACMP
- One 1-channel TPM
- One 8-bit MTIM
- 4-channel KBI

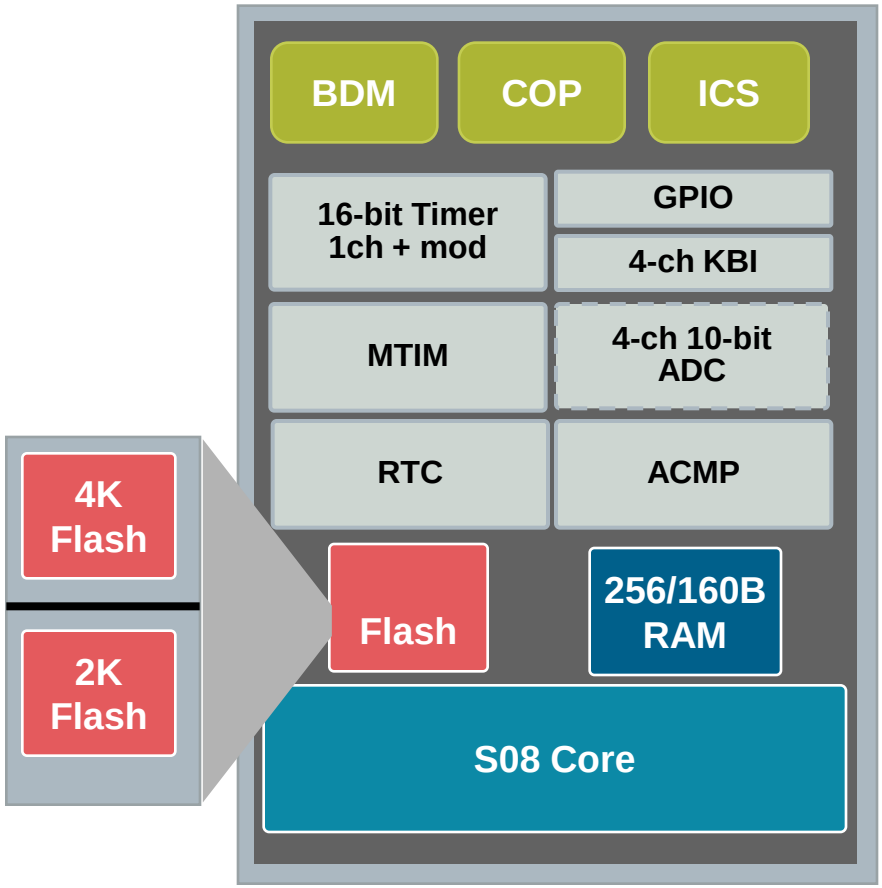
Input/Output
- 5 GPIOs and 1 output only pin

Development Support
- Demo board — DEMO9S08QA4E
- S08 application notes
- CodeWarrior™

Power Saving Mode
- Wait mode
- Stop1, Stop2, Stop3 modes

Packages:
- 8SOIC / 8DFN / 8PDIP

Others
- Pin compatibility with existing 8pin QG
- Flash programmable @ 1.8v



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MC9S08QB8/4

Core

- S08 8-bit CPU w/ 10MHz bus (20MHz CPU)
- -40 to 85C

Memory

- *8K FLASH, 512 RAM*

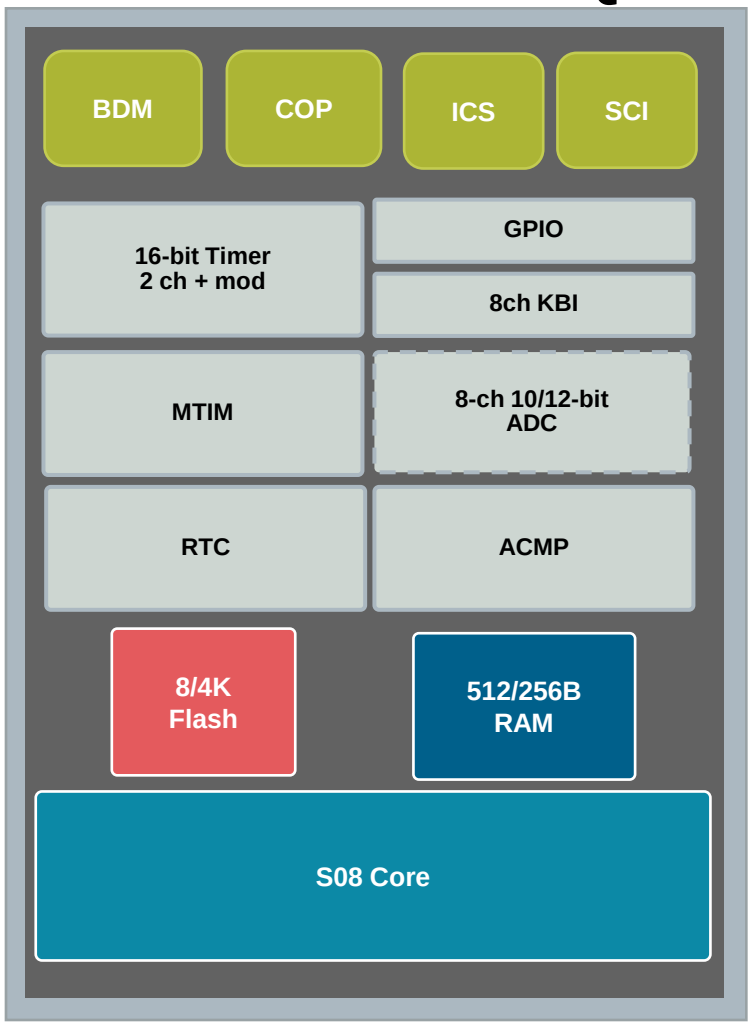
Features/ Benefits

- 2 very low power stop modes
- Vreg w/ fast start-up time and low-regulation voltage
- Computer Operating Properly and LVI with selectable trip point
- 8 ch, 10/12-bit Analog to Digital Converter
- SCI
- Precision trimming Internal Clock Source provide 0.2% resolution with 2% deviation for full operating temperature and voltage
- 1x two-channel 16-bit Timer with selectable IC, OC, or PWM
- Port : 24/20/13 GPIO

Available Packages

- 28 pin SOIC
- 24 pin QFN
- 16 pin TSSOP

***Varies by package**



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MC9S08QB8 vs. MC9S08QE8

Feature	MC9S08QB8	MC9S08QE8
Flash (Bytes) / RAM (Bytes)	8192 / 512	8192 / 512
Pins	28 / 24 / 16	32 / 28 / 20 / 16
ACMP	1	Up to 2
ADC Channels / Resolution	8 / Up to 12-bit	Up to 10 / Up to 12-bit
SCI	1	1
SPI	-	1
IIC	-	1
RTC	Yes	Yes
ICS	Yes	Yes
XOSCVLP	Yes	Yes
TPM (# / Channels)	1 / 1	2 / Up to 3
MTIM	Yes	-
IRQ	Yes	Yes
KBI	8	8
I/O	24 / 20 /14	26 / 22 / 16 / 12
Packages	28SOIC / 24QFN / 16TSSOP	32LQFP / 28SOIC / 20SOIC / 16PDIP/TSSOP
Price (10k# Resale)	From $0.85	From $1.08

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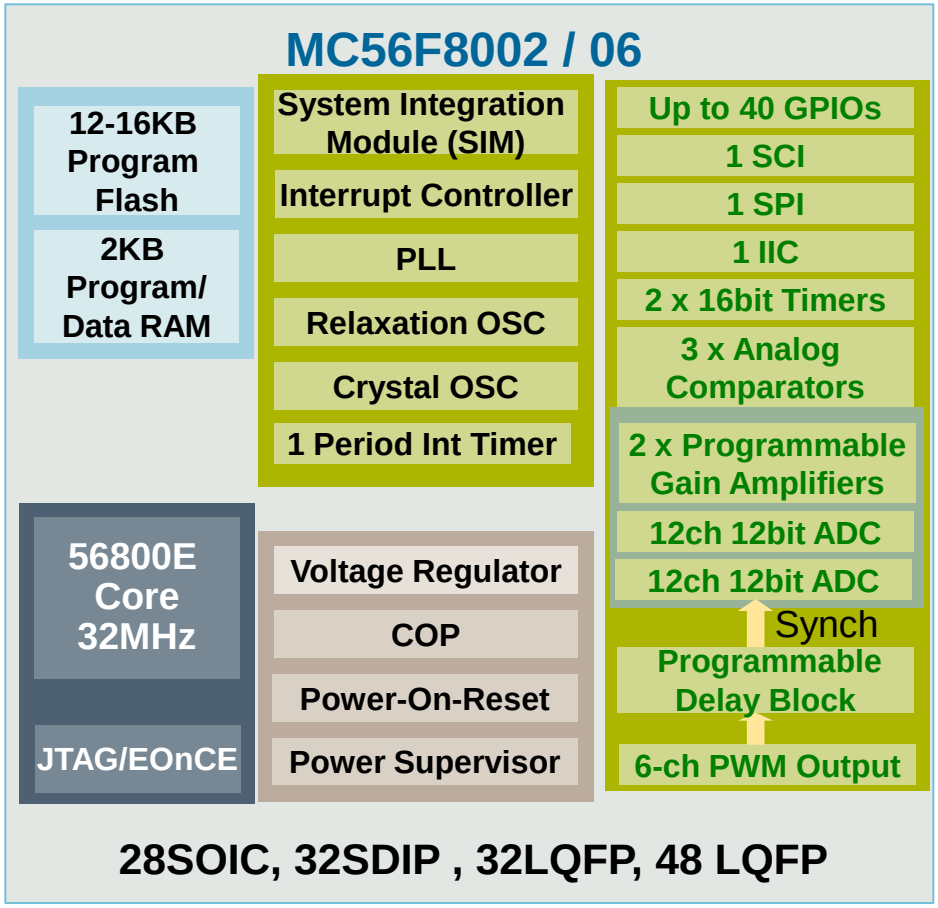

- 32 MHz/32 MIPS 56800E Core
- 1.8-3.6V Operation
- 12K - 16K Bytes Program FLASH with Flash security
- 2K Bytes Program/Data RAM
- Tunable Internal Relaxation Oscillator and 32KHz clock
- Phase Locked Loop (PLL)
- **Up to 96 MHz Peripherals – Timers, PWM & Hi-SCI**
- **6 Output PWM Module with 4 Programmable Fault Inputs**
  - **Programmable Dead timer insertion**
  - **Programmable PWM generation for Power supply apps**
  - **Multiple PWM Frequency outputs**
- **Two Programmable Gain Amplifiers with x2, x4, x8, x16 gains (Clocked in order to cancel input offset)**
- Two 12-bit ADCs with up to 24 Inputs , 2.5us Per conversion
- **Programmable Delay Block provides precise control of ADC/PGA sample times relative to PWM reload cycles**
- Three High Speed Analog Comparators
- 2 multiple function Programmable Timers
- Computer Operating Properly Timer
- One Periodic Interval Timer (PIT)
- 1 High Speed Serial Communication Interface (Hi-SCI)
- 1 Serial Peripheral Interface (SPI)
- I^2C Communications Interface
- Up to 40 GPIOs – Versatile pin usage
- JTAG/EOnCE™ Debug Port
- Lead Free “Green” Packages
- Industrial temp: -40C – 105C
- Suggested Resale Price<$2.00

MC56F8006/2 uses the same low power design process & peripherals as the Flexis QE family

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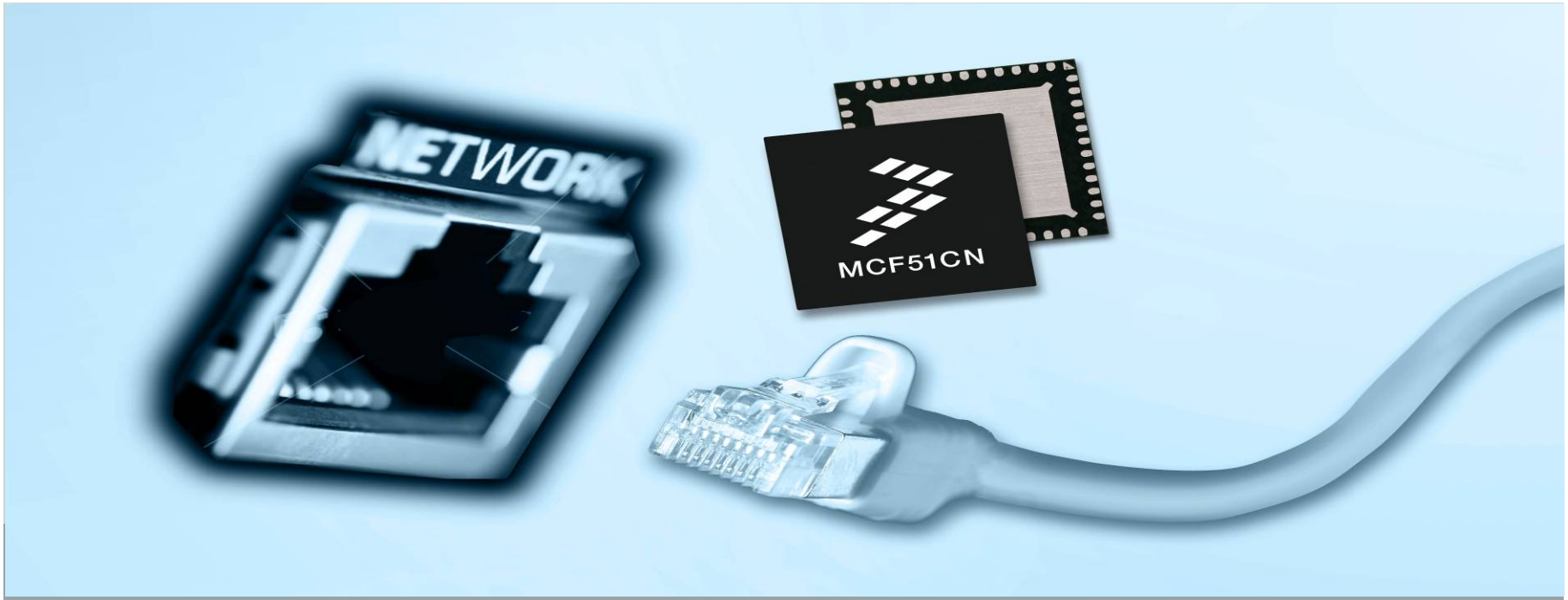

MCF51CN128

Low Cost Ethernet Solution

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MCF51CN128: Overview

Think small—*small* cost, *small* power, *small* size and *big* performance with the new MCF51CN128 MCU featuring on-chip Ethernet and world-class tools to help you connect anything, anywhere.

Small Cost	Small Power	Small Design Time
The compact, cost-effective 8-bit MCU helps you reduce board space and lower costs	Low-power Ethernet MCU for industrial applications.	With Freescale MQX, CodeWarrior and world-class resources, the MCF51CN offers one connectivity solution to help you develop quickly and easily.
• 48QFN (7mm x 7mm) package provides an ultra-small 10/100 BASE-T Ethernet MCU solution—perfect for small serial to Ethernet gateway devices	• Ultra-low-power modes allow deep sleep options, one of which allows limited use of peripherals, perfect for remote battery backed- up networks and POE devices.	• We offer a range of enablement solutions (lwIP, uIP, freeRTOS, and MQX) from simple operating systems to full-featured Ethernet stacks for quick and complete development.
• Very low-cost Ethernet MCU with 10/100 BASE-T Media Access Controller (MAC), only needs external PHY and crystal. Offers future compatibility with Gigabit Ethernet.	• In reduced-power wait mode, Ethernet can continue DMA transfers to RAM and wake up the CPU upon completion.	• The Tower board is a modular development and demo platform to help you quickly evaluate the MC51CN as well as other MCUs and prototype the end application.
• External bus interface allows designers to expand the memory to serve multiple web pages or collect data, as well as connect to custom interfaces via programmable logic.	• Pins and clocks to peripherals not available in smaller packages are automatically disabled for reduced current consumption; no user interaction is needed.	• ZeroG Wi-fi chips interface to our MCUs to provide simple, low-cost wireless connectivity to your Ethernet system.
• Provides an external PHY clock output, reducing components, BOM cost and offering low-cost connectivity for any application.	• Peripheral clock enable register can disable clocks to unused modules, reducing currents. Useful to minimize current consumption from system.	• Freescale MQX task aware debugging with CodeWarrior™ v7.1.1 & IAR Systems software to speed and simplify the development process.

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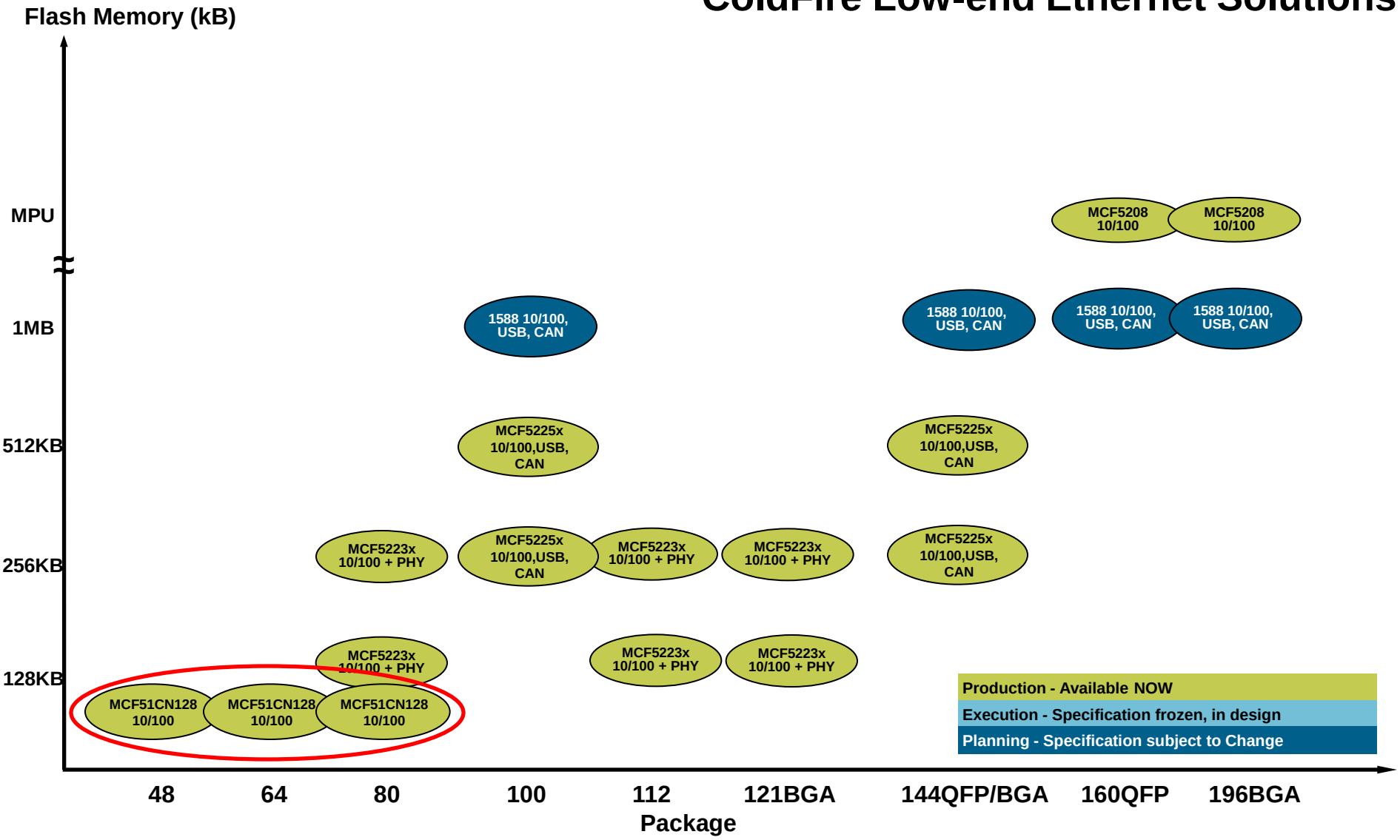
ColdFire Low-end Ethernet Solutions



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MCF51CN128

68K/ColdFire® V1 Core

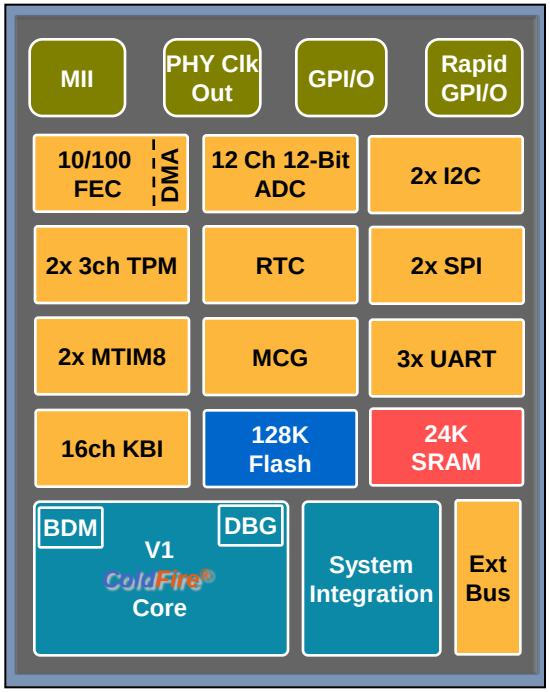
- Up to 46 Dhrystone 2.1 MIPS @ 50 MHz
- Mini Flexbus support up to 1MB external memory (80LQFP) support 2 Devices

Memory

- 128K bytes flash
- 24K bytes SRAM

Features

- Ethernet:
  - 10/100 FEC – Fast Ethernet Controller with DMA
  - MII Interface with Output Clock for PHY
  - Support Half/Full Duplex
- Low power mode – Ethernet operation supported at 3V and above
- Ultra-small (7x7mm) 48-pin package
- 12-Ch, 12-Bit ADC
- 3x UARTs (2 on 48 pin, 3 on 64/80 pin)
- 2x SPI
- 2x I^2C bus interface
- Real Time Counter
- Up to 70 General-Purpose I/O
- System Integration (PLL, SW Watchdog)
- Single Voltage Supply 1.8-3.6V



Part #	Package	ADC Ch	KBI	Port I/O	Rapid GPIO	SCI (UART)	TPM Ch	Ext Bus lines addr/data/chip select	10K# SRP
MCF51CN128CLK	80LQFP	12	16	70	16	3	6	20 / 8 / 2	$3.31
MCF51CN128CGT	64LQFP	12	12	54	16	3	6	-	$3.21
MCF51CN128CLH	48QFN	12	6	38	8	3	6	-	$2.99

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MCF51CN128: Target Applications

- **Industrial Operator Interfaces**
  - Robotic control systems
  - Industrial machine control systems
  - Diagnostic equipment
  - Factory maintenance control systems

- **Consumer and Industrial Appliances**
  - High-end consumer refrigerators, stoves and dishwashers
  - Industrial/commercial cooking systems and refrigerators
  - Consumer/commercial blenders and coffee makers
  - Commercial/industrial washing machines and dryers

- **Medical Monitoring and Instrumentation**
  - Hospital and consumer blood glucose, heart rate and blood pressure monitors
  - Hospital bed controls
  - High-end wheel chair control systems

- **Point of Sale and Courier Systems**
  - Automated grocery checkout control systems
  - Retail or courier barcode scanners and printers
  - Gas station point of sale control systems
  - Automated airline or hotel check-in/check-out systems

- **Security and Building Control Systems**
  - Security system control panels
  - Home/building automation systems
  - Commercial and industrial HVAC control systems
  - Environmental control systems

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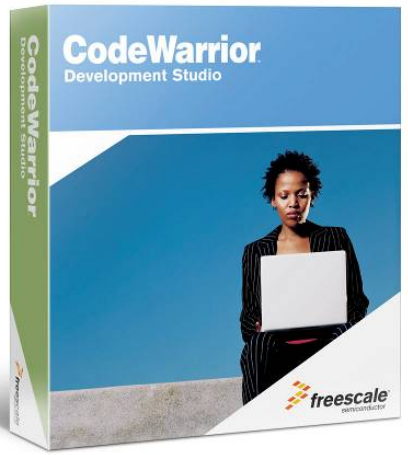
MCF51CN128: Development tools & MC Qual

- CodeWarrior for Microcontrollers v6.2
  - **CWX-HXX-SE**
  - Complimentary Special Edition supports up to 32KB
  - Includes Processor Expert
- **CodeWarrior Patch 6.2.2** for MCF51CN128
  - Install v6.2 prior to v6.2.2 patch.



- **MC Qualification**
  - 80LQFP: Mar09
  - 64LQFP: May09
  - 48QFN: May09

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TWR-MCF51CN-KIT

•Each kit contains separately packaged “DVD cases” that include each of the modules included in the kit
•An outer wrapping/box will surround the group of module cases
•Each module case can be stored at PDC and purchased separately from kit (stand-alone)

	Box 1	Box 2	Box 3	Complete Kit
Module Name	Lasko MCU Story	Serial Story	Elevator	Lasko Tower Kit
Part Number	TWR-MCF51CN	TWR-SER	TWR-ELEV1	**TWR-MCF51CN-KIT ($79)**
Case	1” thick	1.5” thick	1” thick	Outer wrap
Contents of case	•TWR-MCF51CN •1 USB cable •DVD •Lab sheet (hole punched but not in sleeve) •Quick Start Guide •3 sleeves • 2 regular sleeves (DVD, cable) • 1 antistatic sleeve (board)	•TWR-SER •1 Ethernet Cable •1 USB Cable •3 sleeves •2 regular sleeves (cables) •1 antistatic sleeve (board)	•TWR-ELEV •TWR-DELEV •1 antistatic sleeve (board)	• Box 1 • Box 2 • Box 3

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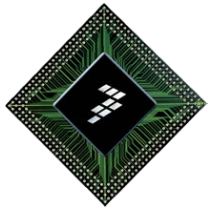
Low Power Features



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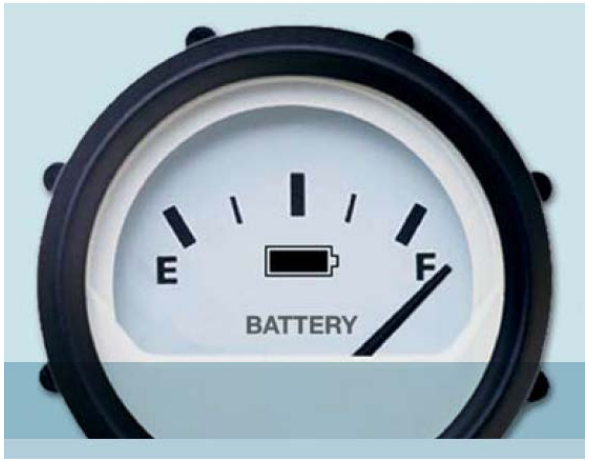
Freescale Low Power Features

1. Multiple power-saving modes
   - 6 modes totally
   - Low-power run and wait modes New
2. Clock gating for the periphrals
3. Internal Clock Source (ICS) module allows to generate clock signals from a variety of sources
4. Ultra-low-power (ULP) 32kHz oscillator
5. New voltage regulator
   - Faster wake up times 6uS
6. Low power Peripherals Real Time Counter
   - Ultra-low power Real Time Counter (RTC)
   - Low power ADC



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Operation Modes

Highest functionality ⟷ Lowest power

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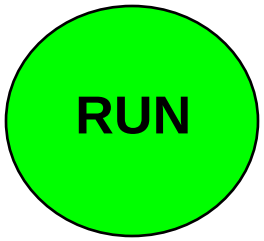
QE8 – Run Mode

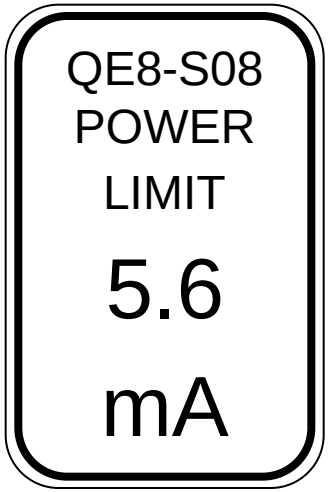
Run Mode

- Standard user mode – default mode out of any reset
  - Clocks are enabled to CPU and all peripherals
  - All peripherals disabled out of reset.
- The voltage regulator is in active mode
- Typical IDD as low as **5.6 mA** at 10 MHz Bus and 3V with all modules enabled.



Advantages

- All peripherals can be used without limitations
- Interrupts can be serviced without changing modes
- Flash can be reprogrammed across all VDDs and temperature



Limitations

- Consumes more current than other modes

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QE8- Wait Mode

Wait Mode

- The bus clock source remains active
- Clocks are disabled to CPU but peripherals can be clocked
- Typical IDD as low as 0.57 mA at 10 MHz CPU and 3V

Advantages

- Reduces power consumption versus run mode
- No stop recovery time; the interrupt is serviced immediately
- Reduces noise while taking A-to-D readings

POWER
LIMIT
10 MHz Bus
570
uA

Limitations

- The voltage regulator remains active, consuming more current than stop or LP modes

Exit times :

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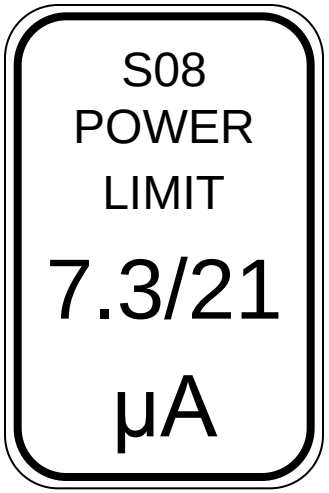
QE8 Low-power Modes : LPRun

New

Low-power Run (LPRun) Mode

- The bus clock source is limited to FBELP
- Typical IDD as low as 7.3 µA at 32 kHz CPU and 3V when executing from RAM
- Typical IDD as low as 21 uA at 32 kHz CPU and 3V when executing from Flash
- The voltage regulator is in low-power mode



Advantages

- All peripherals can be used
- Reduces power consumption versus Run mode when high performance is not required
- Interrupts can be serviced without changing modes

Limitations

- Maximum frequency is limited (see reference manual)
- Flash cannot be programmed or erased

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Low-power Modes—LPWait

New

Low-power Wait (LPWait) Mode

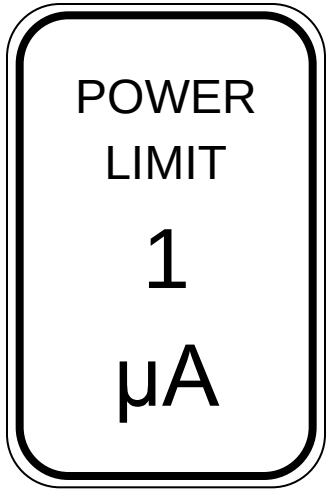
- The bus clock source is limited to FBELP
- Clocks are disabled to CPU but peripherals can be clocked
- Typical IDD as low as 1 µA at 32 kHz CPU and 3V
- The voltage regulator is in low-power mode

Advantages

- Reduces power consumption versus LPRun mode
- No stop recovery time; the interrupt stacking begins immediately
- Reduces noise while taking A-to-D readings

Limitations

- Consumes more current than stop modes
- Maximum frequency is limited
- Due to slower frequencies, may take longer to react to wake-up trigger than stop2 or stop3 modes



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QE8-Low-power Modes: Stop3

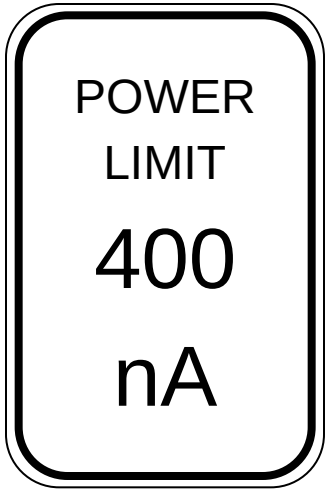
Stop3 Mode

- Bus and CPU clocks halted
- Voltage regulator in standby
- Typical IDD of 400 nA at 3V
- Exit with any active interrupt: ADC, ACMP, IRQ, KBI, LVD, RTC, SCI or reset

Exit times : 6 uS

Advantages

- Still has very low-current consumption
- RAM and register retain their values
  - **Does not require reinitializing peripherals**
- Latency from interrupt event to code execution is only 5 us + 38 ICSOUT cycles



Limitations

- Not quite as low current as stop2

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QE8- Low-power Modes: Stop2

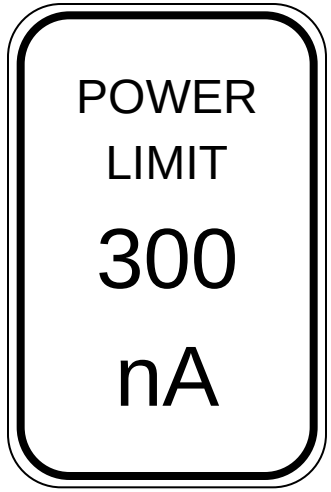
Stop2 Mode

- Partial power down mode with typical IDD as low as 300 nA at 3V
- Exit with wake-up pin (IRQ/RESET pin) or RTC
  - **Stop2 recovery is always through a system reset**

Advantages

- Lowest-power consumption mode for these devices
- RAM contents are maintained, I/O pin states are latched.

Exit times : 29 uS



Limitations

- Register values are reset, but values can be saved to and restored from RAM
- Wake up latency from reset to code execution is ~5 us + 162 ICSOUT cycles.

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CPU Mode Comparison Chart

	Features	Exit Sources	Wake-up Time
Run	**CPU clocks can be run at full speed Internal supply is fully regulated**	n/a	n/a
Wait	**CPU not clocked System clocks are running Full regulation is maintained**	Any interrupt	Instantly
LP Run	**Bus frequency is restricted to 125 kHz maximum Voltage regulator standby**	Clear LP bit or interrupt with LPWUI set	n/a
LP Wait	**CPU not clocked Bus frequency is restricted to 125 kHz maximum Full regulation is maintained**	Any interrupt	Instantly
Stop 3	**CPU not clocked Voltage regulator stand by Peripherals not clocked but powered for fast recovery**	RTC, LVD/LVW, ADC, ACMP, IRQ, SCI, KBI or RESET	6 µs
Stop 2	**CPU and peripherals not clocked Voltage regulator partial power down RAM content is retained**	RTC, IRQ or RESET	29 µs

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New Voltage Regulator

- Voltage Regulator is always on when MCU is in Run or Wait modes
  - Also on when in stop3 with LVI or ADC enabled
  - Runs internal logic at lower voltage, therefore lower power

- Modified stand-by mode to allow execution in low power modes
  - New LPRun and LPWait modes allow peripherals to run while regulator is in stand-by
  - Condition for this is to have ICS configured in a special low power modes where bus frequency is restricted (125 KHz max)
  - *New faster regulator start-up time!* ***6 uS***
  - Allows more applications to use Stop modes

Periphrals Clock Gating
µA Saved Through Clock Gating @ 20MHz CPU in FEE Mode

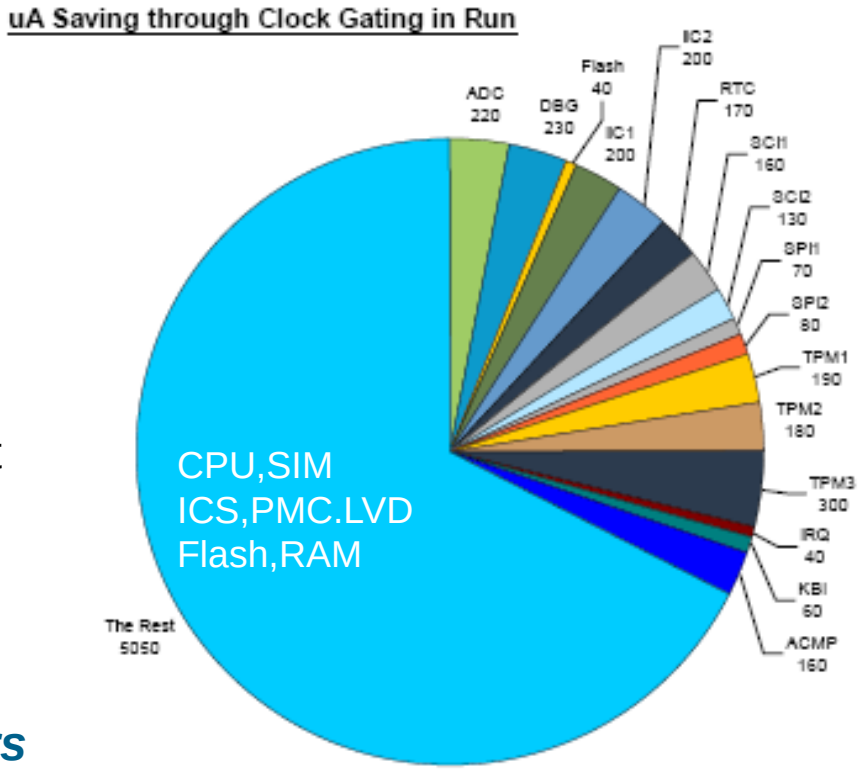
Clock gating is the mechanism used to disable the clock tree to any unused peripheral

Bus or peripheral clock runs to all modules

- Regardless if they are enabled or not

Saves power by not clocking unused gates

Using the system clock gating registers RUN IDD can be reduced by up to ~33%



Total Run Current with all module clocks disabled = 5050uA
Total Run IDD with all module clocks enabled = 7480uA

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How does Power Relate to ICS?

Software-selectable bus frequency divider (BDIV)

- Available in all clock modes
- Allows frequency changes without losing FLL Lock in FEI and FEE
- Run fast only when needed

Low-power or high-gain oscillator options

- Low-power limits voltage swing on oscillator pins to minimize power consumption

The external reference can be left enabled in stop mode

- 32 kHz crystal in low-power mode only adds 800nA to stop mode currents!

Stop mode currents are affected only by the references enabled in stop mode, not the ICS mode before entering

- Ex: if running FEE mode with ext oscillator enabled in stop mode, only the ext oscillator will be enabled when stop is entered, the FLL will be disabled automatically

Ultra-low Power Real-time Counter (RTC)

Enhancement from Real-Time Interrupt Module

1 kHz internal low-power oscillator (LPO)

- 300 nA typical power consumption
- No crystal required
- Independent of internal bus clock source

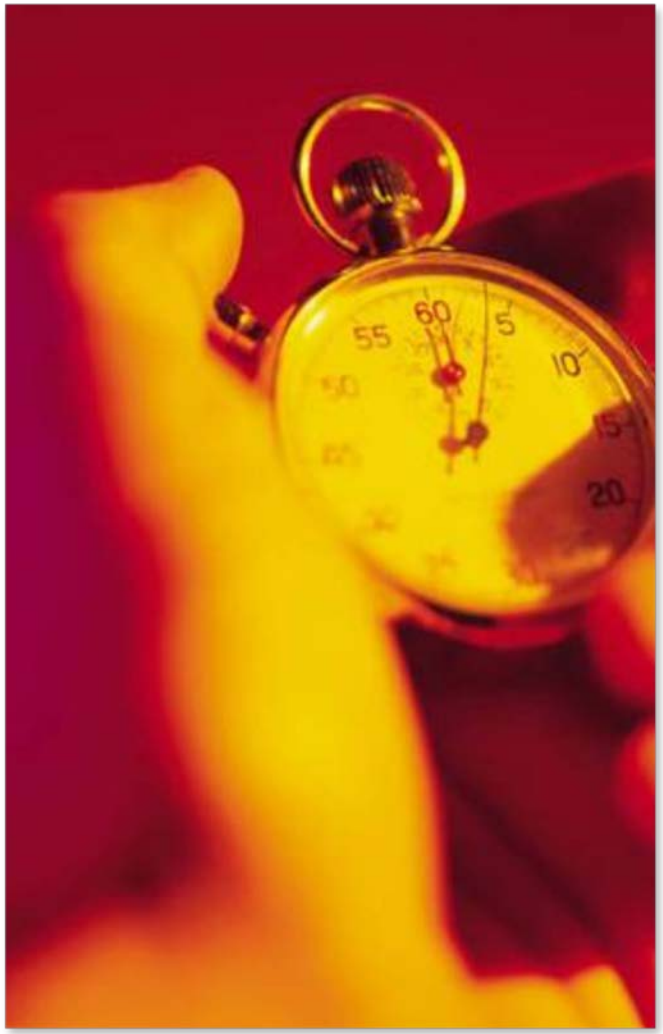
External clock option for greater accuracy

- 550 nA typical power consumption with 32 kHz low power oscillator

Programmable wake-up intervals

- 8-bit counter
- 15 selectable input clock prescalers
- 8-bit user programmable modulo value

Can be enabled in any mode



TIP

The internal LPO oscillator can be measured against the bus clock. User software can adjust RTC timeout to compensate for inaccurate LPO clock.

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System Clock Gating Registers

	7	6	5	4	3	2	1	0
R W	TPM3	TPM2	TPM1	ADC	IIC2	IIC1	SCI2	SCI1
Reset:	1	1	1	1	1	1	1	1

Figure 5-12. System Clock Gating Control 1 Register (SCGC1)

	7	6	5	4	3	2	1	0
R W	DBG	FLS	IRQ	KBI	ACMP	RTC	SPI2	SPI1
Reset:	1	1	1	1	1	1	1	1

= Unimplemented or Reserved

Figure 5-13. System Clock Gating Control 2 Register (SCGC2)

1 - (default after reset) module is clocked
0 – module is not clocked

Peripherals are disabled on reset, but are clocked.
Users can save on power by gating clocking to unused peripherals

QE128 Clock Gating
µA Saved Through Clock Gating @ 20MHz CPU in FEE Mode

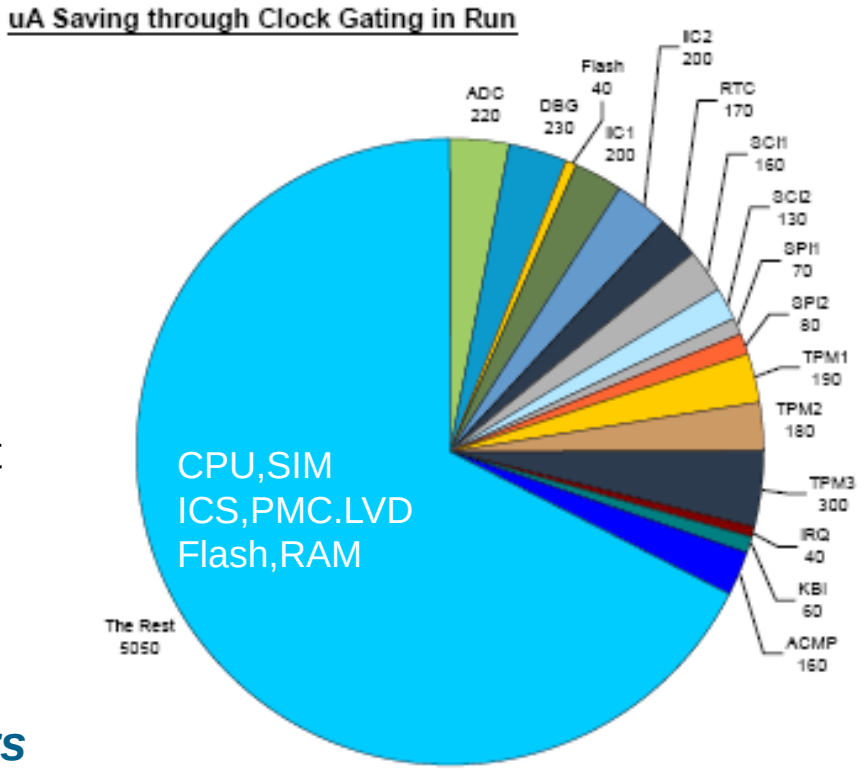
Clock gating is the mechanism used to disable the clock tree to any unused peripheral

Bus or peripheral clock runs to all modules

- Regardless if they are enabled or not

Saves power by not clocking unused gates

Using the system clock gating registers RUN IDD can be reduced by up to ~33%



Total Run Current with all module clocks disabled = 5050uA
Total Run IDD with all module clocks enabled = 7480uA

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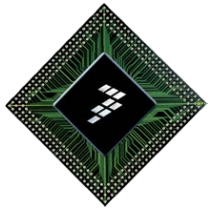
Low Power example - Periodic Sensor Reading



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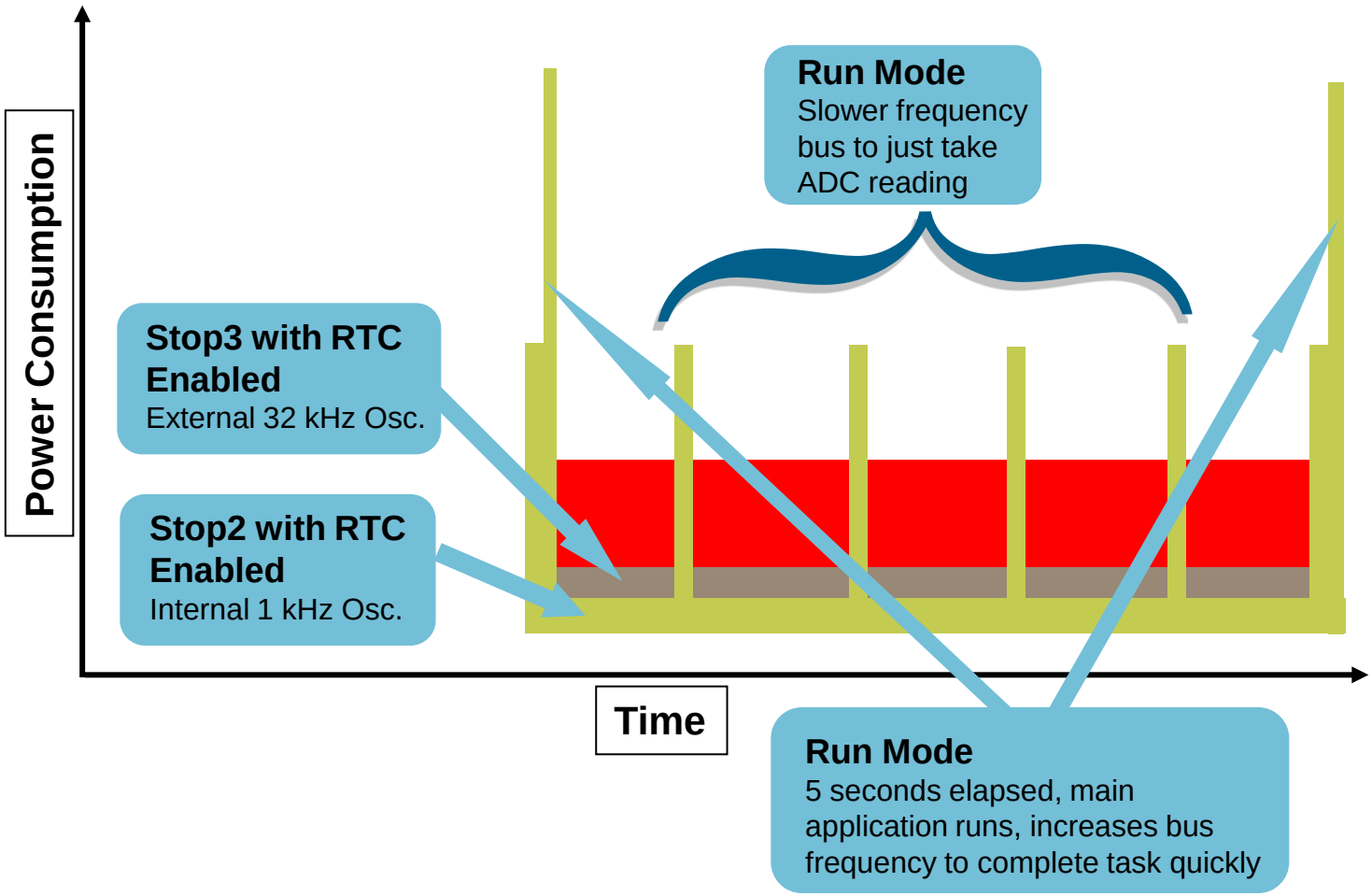
Periodic Sensor Reading

Example: Need to wake every second and read sensor. Every 5 seconds, process data and send result to host (PC).

Which approach uses less power?

1. Run MCU in low-power run the entire time
2. Use MCU's RTC with a crystal to provide accurate clock during Stop3 mode
3. Use MCU's RTC with internal LPO reference during Stop2 mode

Extending Battery Life—Clock Management



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Mode Definitions for Low-power Example

Mode	Description	S08	V1
Stop2 with RTC (1kHz LPO)	External clock is off; RTC is running with internal reference clock	670 nA	670 nA
Stop3 with RTC (32kHz crystal)	External clock is on at 32 kHz; RTI is running off external clock	920 nA	980 nA
Run (FBELP) ADC off	Core is fully functional at 16 kHz bus speed. Clock gates are closed on all unused modules. ADC in low-power mode	22 uA	50 uA
Run (FBELP) ADC reading	Core is fully functional at 16 kHz bus speed. Clock gates are closed on all unused modules. ADC in low-power mode	224 uA	252 uA
Run (FEE/FEI) ADC reading	Core is fully functional at 8 MHz bus speed. Clock gates are closed on all unused modules. ADC in high speed mode	5.1 mA	11.9 mA
Run (FEE/FEI) ADC off	Core is fully functional at 24 MHz bus speed. Clock gates are closed on all unused modules. SCI baud = 115.2 kbps	12 mA	27 mA

Approach 1: Average Current

Keep MCU running at low frequency with RTC providing 1 second intervals to take ADC reading:

Average current = MCU run current at 16 kHz bus ADC off x % time
+ MCU run current at 16 kHz bus ADC on x % time

S08 = 22 uA x (5 sec – 5 x ADCLP conv time)/5 sec
+ 224 uA x (5 x ADCLP conv time)/5 sec
= 22.1 uA

V1 = 50 uA x (5 sec – 5 x ADCLP conv time)/5 sec
+ 252 uA x (5 x ADCLP conv time)/5 sec
= 50.1 uA

(one ADCLP conversion time = 329 usec with 16 kHz bus)

Approach 2: Average Current

Use crystal on MCU to provide accurate clock during Stop3. Use RTC to wake every second for ADC measurement. Every 5th measurement ramp frequency and process data:

Average current = MCU Stop3 current w RTC and xtal × %time
+ MCU Run current while ADC on × %time
+ MCU Run current while communicating × %time

S08 = 920 nA × (5 sec - 5 x ADCHS conv time – processing time)/5 sec
+ 5.1 mA × (5 x ADCHS conv time)/5 sec
+ 12 mA × (processing time)/5 sec
= 0.92 uA + .018 uA + 0.192 uA = 1.13 uA

V1 = 980 nA × (5 sec - 5 x ADCHS conv time – processing time)/5 sec
+ 11.9 mA × (5 x ADCHS conv time)/5 sec
+ 27 mA × (processing time)/5 sec
= **0.98 uA + 0.042 uA + 0.11 uA = 1.13 uA**

Notes: One ADCHS conversion time = 3.5 usec with 8 MHz bus. Assuming processing time of 2000 cycles for S08, 500 cycles for V1

Approach 3: Average Current

Use LPO on MCU to provide clock during Stop2. Use RTC to wake every second for ADC measurement. Every 5th measurement ramp frequency and process data:

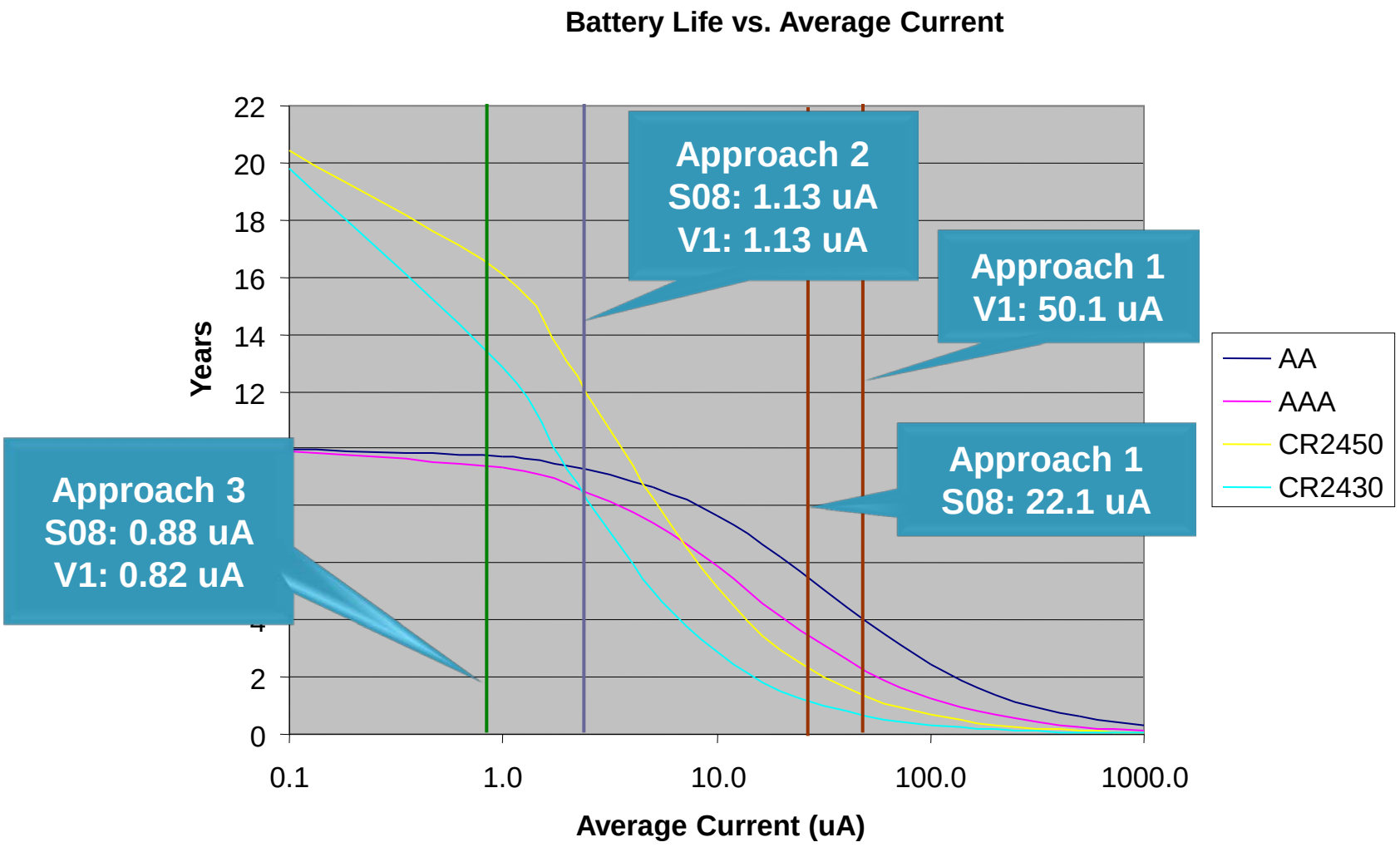
Average current = MCU Stop2 current w RTC and LPO× %time
+ MCU Run current while ADC on × %time
+ MCU Run current while communicating × %time

S08 = 0.67 uA × (5 sec - 5 x ADCHS conv time – processing time)/5 sec
+ 5.1 mA × (5 x ADCHS conv time)/5 sec
+ 12 mA × (processing time)/5 sec
= 0.67 uA + .018 uA + 0.192 uA = 0.88 uA

V1 = 0.67 uA × (5 sec - 5 x ADCHS conv time – processing time)/5 sec
+ 11.9 mA × (5 x ADCHS conv time)/5 sec
+ 27 mA × (processing time)/5 sec
= 0.67 uA + 0.042 uA + 0.11 uA = 0.82 uA

Notes: One ADCHS conversion time = 3.5 usec with 8 MHz bus. Assuming processing time of 2000 cycles for S08, 500 cycles for V1

Battery Life vs. Average Current



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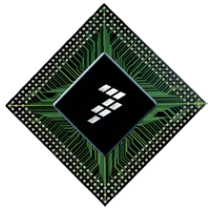
Sensor Example Notes

- LPRun and LPWait modes are most useful when a module that cannot run in stop modes is needed all the time.
- LPRun currents fall dramatically if code can be executed from RAM instead of Flash.
- Stop3 mode can be entered directly from LPRun mode to save additional current. Stop2 mode cannot.
- As the time spent running code increases, the V1 can surpass the S08 in power efficiency, particularly when performing frequent and/or long calculations.



Low Power Developer Resources

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Application Notes & Training Resources

- **Application Notes**
  - AN3460 Low Power Design enabled by MC9S08QE128 & MCF51QE128 MCUs
  - AN3629: Migrating from the 9S08QE32 to the MCF51QE32
  - AN3502: Differences between the TI MSP430 and QE128
  - AN3506: Migrating from TI's MSP430 to the 9S08QE128 or MCF51QE128
  - AN3467: Using Processor Expert with Flexis MCUs
  - AN3464: Migrating code between ColdFire V1 and V2
  - AN3466: Differences Between a Cortex M3 Processor and the MCF51QE128
  - QRUG QE128 (QE128 Peripheral Module Quick Reference Guide)

- **Flexis QE Virtual Lab @ http://www.techonline.com/product/virtualab/202200251**

- **Online training presentations @ www.freescale.com/flexis**

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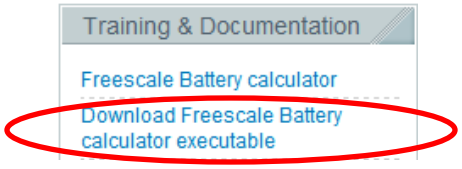
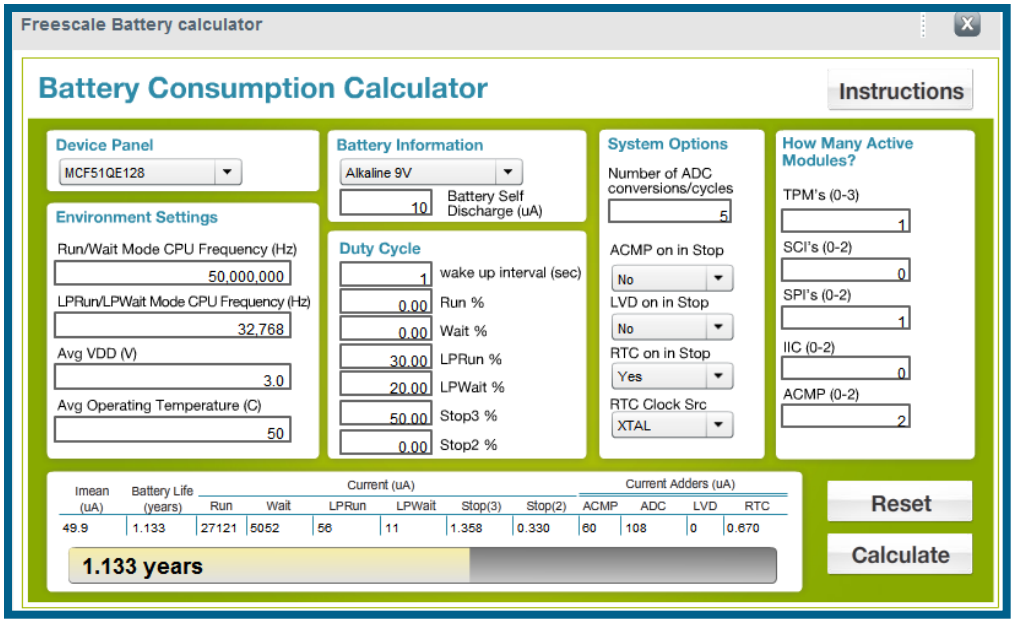
Training Resources

- **FTF Training Material**
  - AC123_Hands-on Workshop: Designing for Low-Power in the Real World with the Controller Continuum and Flexis QE Devices
  - http://www.freescale.com/files/ftf_2008/presentations/Americas/2/AC123_HandsonWorkshopDesigningforLowPowerintheRealWorldwiththeControllerContinuumandFlexisQEDevices.pdf

Freescale Battery Life Calculator

- www.freescale.com/lowpower
- Determines the average current the MCU is consuming and estimate the resulting battery life
- Based on application system variables: V, Hz, C, % of time in in MCU modes (run, wait, stop3, stop2 and stop1), periodic wakeup interval
- User can select from a variety of standard battery sizes and types or enter battery characteristics directly





- Devices currently supported: S08QE128/96/64, MCF51QE128/64/32, S08QE8
- Additional devices will be added as they are introduced to market

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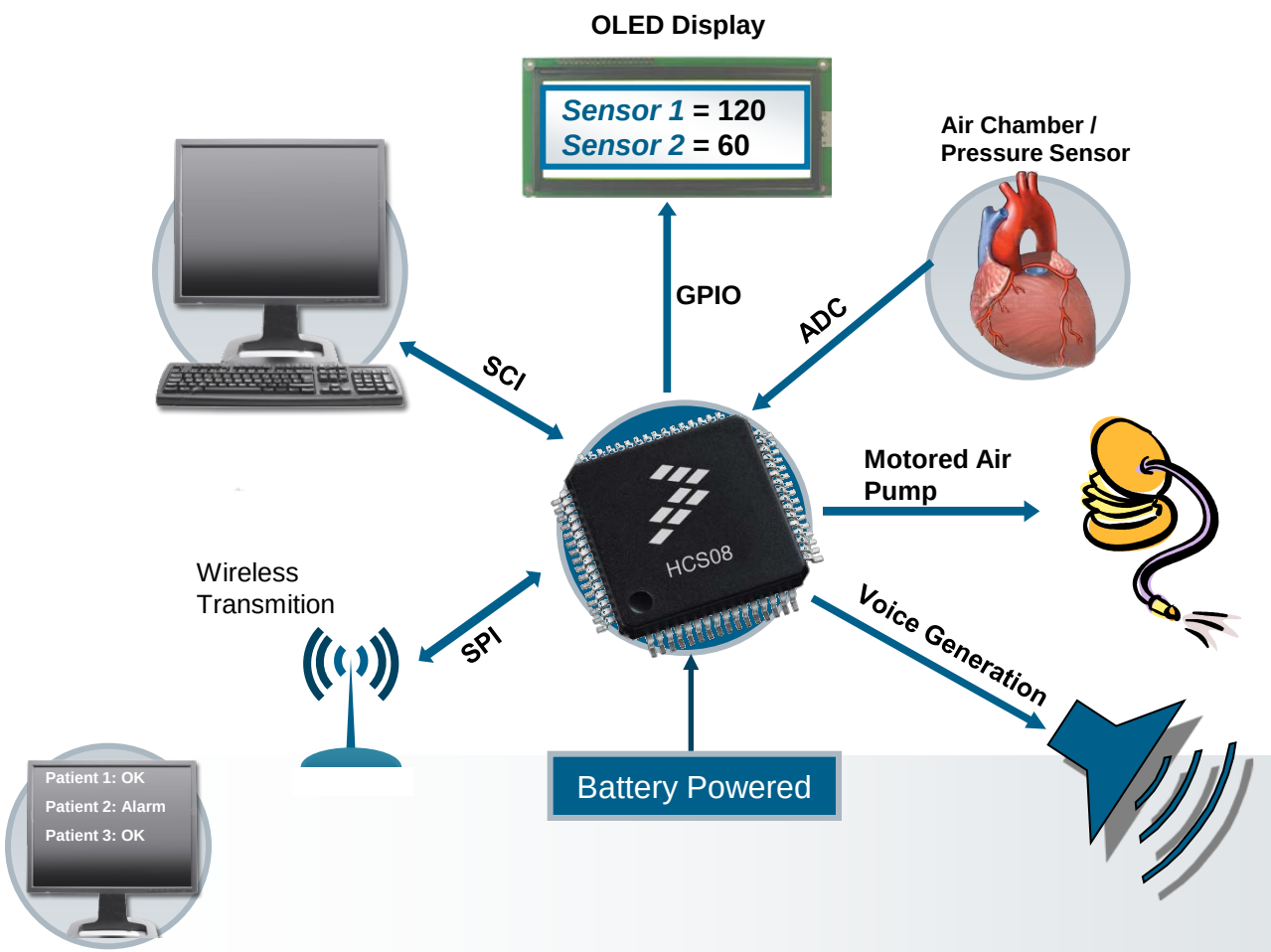
Demo: Low-end Blood Pressure Monitor



Benefits with S08QE:

- Low -power consumption for battery-operated devices
- 11 GPIO for character LCD use
- Data can be monitored and graphed in computer

S08 selection criteria:

- Absolute minimum power consumption required
- Low pin count or pin count options desired
- No application requirement for higher performance calculations or peripherals
- Greater cost sensitivity

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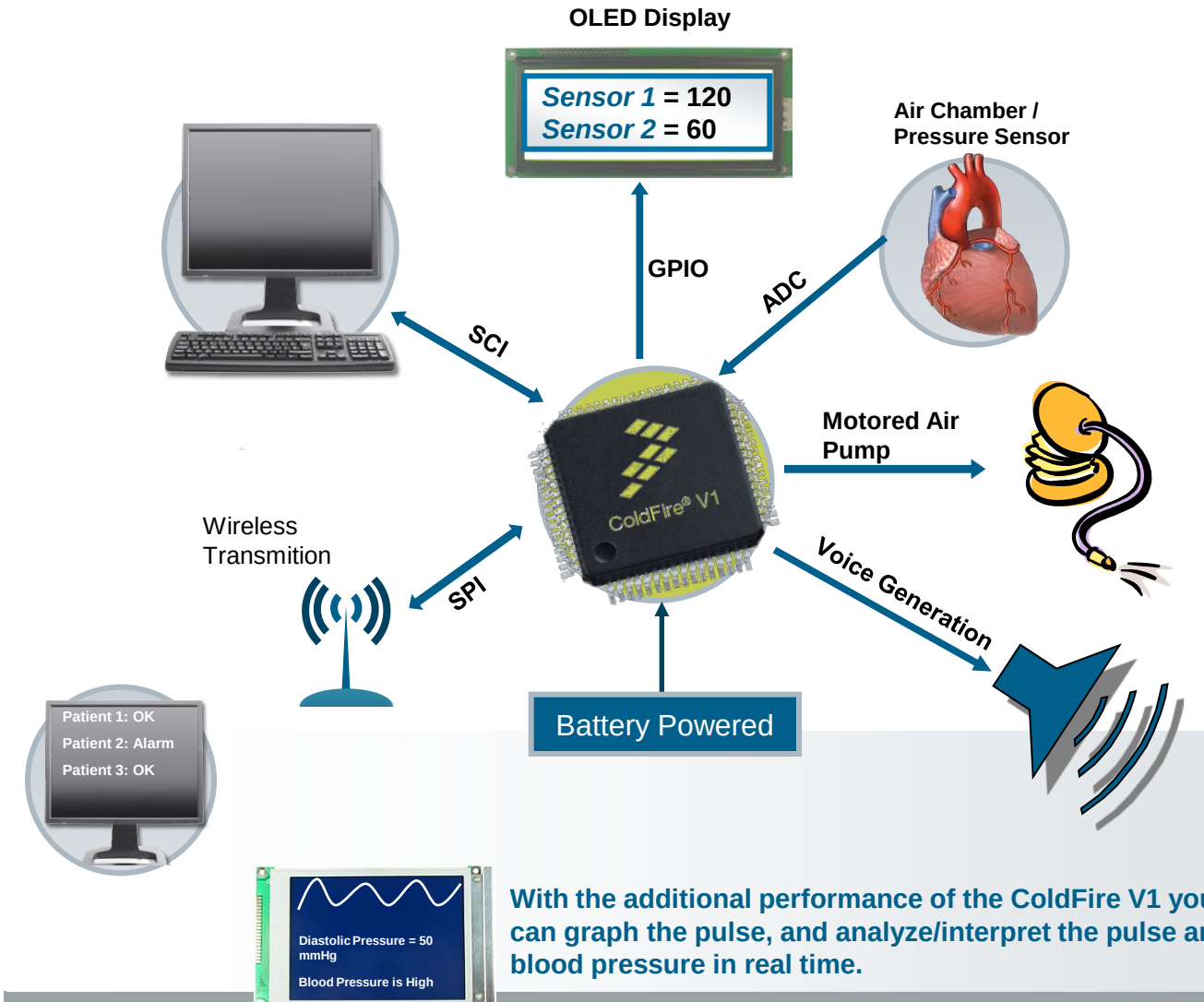
Demo: High-end Blood Pressure Monitor



With the additional performance of the ColdFire V1 you can graph the pulse, and analyze/interpret the pulse and blood pressure in real time.

► Benefits with ColdFire QE:

- Higher processing capabilities—accurate collection and processing of data, driving LCD
- Simultaneous ZigBee connection

► ColdFire V1 selection criteria:

- Need more math processing performance
- Interested in achieving low-cost and low-overhead link to future 32-bit designs
- Need a path to higher flash densities (>128KB)

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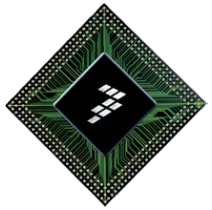
Battery Charging Solutions



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Target Applications for Battery Chargers







Single-cell Li-Ion/Polymer battery powered devices or their accessories






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Freescale Battery Charger Benefits

The industry's most flexible battery charger ICs that can be customized for a wide variety of applications during the final test phase of the manufacturing process

Flexibility	High Performance/Accuracy	Compact Packaging
Not just three devices but a family of devices because of flexibility	These chargers provide the highest performance and accuracy in the industry	Meets customers' needs of manufacturing smaller, lighter portable devices
Process allows quick customization to meet application needs	Output voltage accuracy up to 0.2% at room temperature	2x3 mm ultra thin dual flat no-lead (UDFN)
Pin-out, feature set and charging parameters can be customized to customer requirements	Output voltage accuracy up to 0.4% at over temperature	Low profile package 0.65 mm
Up to hundreds of configurations with initial devices	Charge current accuracy is 6% over temperature	Cost efficient

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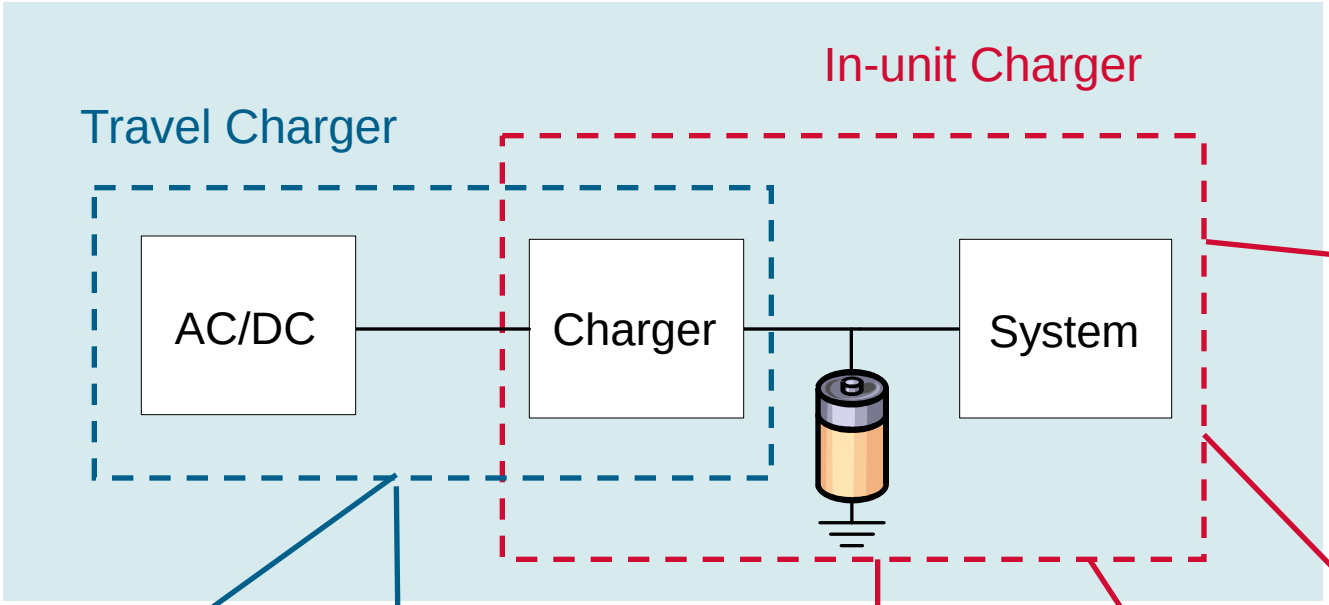
Where Does It Fit in System?



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MC3467x Product Roadmap

A complete family from the low end to the high end….

SINGLE INPUT (USB or AC/DC)

DUAL INPUT (USB AND AC/DC)

Max charge current (A)

1.2A

MC34673
1.2 A charge current
Programmable max current (external resistor)
2x3 DFN8

8-Pin UDFN

MC34676A/B
1.2 A charge current (AC/DC)
400 mA charge current (USB)
AC & USB programmable charge current (ext. resistor)
1/2 additional LDO (A/B version)
3x3 DFN12

1.05A

MC34674 :
factory programmable charge current up to 1.05A
Internal safety timer
smart battery detection
Charge completion indication
NTC input for battery temp monitoring
2x3 DFN8

8-Pin UDFN

1A

MC34675
1A charge current
15 mA / 5V LDO
Programmable max current (external resistor)
2x3 DFN8

8-Pin UDFN

0.6A

MC34671
0.6 A charge current
Programmable max current (external resistor)
2x3 DFN8

8-Pin UDFN

Applications *: PC peripherals, cell phone, blue-tooth headset, MP3, gaming, PMP, portable Medical, POS, bar code scanners*

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Battery Charger Solutions: Product Overview

MC34671	• 600mA charge current
MC34673	• 1200mA charge current
MC34674	• Travel Charger • 1050mA charge current
MC34675	• 1000mA charge current • 4.8V@10mA LDO
MC34676	• 1200mA charge current (AC) • 400mA charge current (USB) • 4.8V@10mA LDO or BATT detect

Highest Performance Chargers in Industry

- 0.4% output voltage accuracy over temperature
- 5% current accuracy

Up to 28V input voltage

Factory-Programmable Parameters for Increased Device Flexibility

- Output voltage
- Input over-voltage protection
- CC current
- Trickle charge current
- Trickle charge voltage threshold
- EOC current
- Recharge threshold
- Thermal fold back threshold
- Timeout
- Verification filter timing

Factory-Reconfigurable Features

- Indicator pin functions are programmable
- ISET pin
- Negative Temperature Coefficient (NTC) thermistor interface
- Battery connection verification
- EOC flow
- Remote sense

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Battery Charger Solutions: Competitive Overview

Vendor	Part Number	Max Input voltage (V)	Max CC (A)	Safety Timer? (Y/N)	Thermal Reg? (Y/N)	Pwr Path mgmt (Y/N)	CC Accuracy (+/- %)	Voltage Accuracy (+/- %)	Status Indication (# of bits)	OVP (V)	Package
TI	bq24061/2/3/4/5/6	18	1	Y	Y	N		0.5	3	6.5V/10.5	3x3DFN-10
TI	bq24030/2/5/8	18	1.5	Y	Y	Y	17	1	4	-	3.5x4.5QFN-20
TI	bq24020/2/3/4/5/6/7	7	1	Y	N	N		1	2	-	3x3DFN-10
Intersil	ISL6294	28	0.9	N	Y	N	10	1	2	6.5	2x3DFN-8
Intersil	ISL6299A	28/7	1	N	Y	N	10	1	2	-	3x3DFN-10
Intersil	ISL6292/B/C/D	7	2	Y	Y	N	10	1	2	-	3x3DFN-10/4x4/5x5
Intersil	ISL6297	7	1.5	Y	Y	N	10	0.7	2	-	4x4QFN-16
Maxim	MAX8808X/Y/Z	16	1	N	Y	N	10	1	2	7	2x2TDFN-8
Maxim	MAX8606	16	1	Y	Y	N		0.5	2	5.8	3x3TDFN-14
Maxim	MAX1551/5	7	0.28	N	Y	N	20	0.5	1	-	SOT23-5
LTC	LTC4055	5.5	1.25	Y	Y	Y	5	1	2	-	4x4QFN-16
LTC	LTC4065	5.5	0.75	Y	Y	N	5	1	1	-	2x2DFN-6
LTC	LTC4059A	10	0.9	N	Y	N	6	1	1	-	2x2DFN-6
LTC	LTC4075	10	0.95	Y	Y	N	5	1	2	-	3x3DFN-10
National	LM3658	6.5	1	Y	Y	N	15	1.5	2	-	3x3DFN-10
Freescale	MC34xxxx	28	1.2	Y	Y	N	5	0.5	3	5.5/6.8/11	2x3DFN-8/2x2DFN-8

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Battery Charger Solutions: Summary

- Industry's most flexible Li-ion and Li-polymer battery charger solution
- Complete charger for single-cell Li-ion and Li-polymer batteries
- Feature-rich and easily modified to meet the needs of a wide variety of applications
  - ✓ • +/-0.7% output voltage accuracy over -20°C to +70°C (+/-0.4% at room temperature)
  - ✓ • +/-0.7% output voltage accuracy over -40°C to +85°C (MC34675)
  - ✓ • +/-5% charge current accuracy over -40°C to +85°C (+/-6% for MC34673
  - ✓ and MC34675)
- Factory-configurable parameters for faster time to market and lower system cost
- Meets AC/DC adapter standard YD/T 1591-2006 in the Chinese cell phone market
- Low external component count

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