8-bit Microcontrollers

MC9S08LL16/8
Fact sheet

Target Applications
- Battery-operated handheld devices
- Portable health care devices
- Thermostats
- Alarms/clocks
- Exercise equipment
- Personal diagnostics
- Calculators
- Low-end utility metering
- ZigBee® nodes with display
- Scrolling text displays
- Small appliances

Overview
Freescale introduces the first S08 ultra-low-power MCU with LCD driver. The MC9S08LL16/8 helps you reach your target performance levels while minimizing power consumption in your design, demonstrating extreme energy efficiency for ultra-long operation in battery-powered applications. The S08LL16 (LL16) microcontroller offers two ultra-low-power stop modes, new low-power run and wait modes, six microsecond wake-up time, ultra-low-power external oscillator and clock gating registers to disable clocks to unused peripherals.

The LL family also provides design flexibility with a large segment-based (8 x 24) driver and an integrated charge pump to provide a true system-on-chip.

Package Options

Part Number	Package	Temp. Range
MC9S08LL16CLH	64 LQFP	-40°C to +85°C
MC9S08LL16CGT	48 QFN	-40°C to +85°C
MC9S08LL16CLF	48 LQFP	-40°C to +85°C
MC9S08LL8CGT	48 QFN	-40°C to +85°C
MC9S08LL8CLF	48 LQFP	-40°C to +85°C

Features	Benefits
S08 Central Processor Unit (CPU)	
• Up to 20 MHZ HCS08 CPU from 1.8V to 3.6V and across a temperature range of -40°C to +85°C	• Offers high performance, even at low voltage levels for battery-operated applications • Provides bus speed operation of 10 MHz from 1.8V to 3.6V
• HCS08 instruction set with added BGND instruction	• Easy to learn and use • Backward object code compatibility with 68HC08 and 68HC05 for reuse of existing libraries • Allows for efficient, compact module coding in assembly or C compiler • BGND allows user to enter background debug mode that takes advantage of the on-chip in-circuit emulator (ICE)
Power-Saving Features	
• Two ultra-low-power stop modes, one of which allows limited use of peripherals	• Allows continued application sampling in a reduced power state, which extends battery life
• New low-power run and wait modes	• Allows use of all chip peripherals in a low-power state
• 6 µs typical wake-up time from stop mode	• Enables faster execution out of stop modes
• Internal clock source (ICS)—module containing a frequency-locked loop (FLL) controlled by internal or external reference	• Provides choice of frequencies on the fly • Reducing frequency saves current
• Ultra-low-power oscillator (OSC)	• Accurate timebase in low-power modes
• Clock gating disables clocks to unused peripherals	• Provides flexibility to turn off individual modules • Reduces power consumption
LCD Driver and Internal Charge Pump	
• Integrated LCD driver supports both standard 3V and 5V LCD glass	• Gives you flexibility when selecting the ideal glass for your application with respect to display quality, cost and power • Does not require expensive “chip-on-glass” display
• Configurable display for 8 x 24 or 4 x 28 segment display	• Up to 16 alpha-numeric display (12 segments based), perfect for scrolling text with simple display • Allows high mix of numbers, text and icons
• Low-power blinking mode	• Low-power blinking mode does not require CPU intervention. Blinking mode can be activated and CPU can go to sleep, but segments will remain blinking at the pre-set frequency. Plus, an alternate display feature can be activated to display alternate data (i.e., to blink temperature and time).
• Internal charge pump	• Provides option to run off a single supply, a dual supply for sustained contrast or a customized implementation of contrast control
• Front plane (FP) and black plane (BP) re-assignments	• FP and BP can be software selectable, making layout an easier task and very flexible for design changes
• Capable of running in STOP3 and STOP2 mode	• Enables driving the display while the CPU sleeps, lowering overall system power consumption
• LCD driver pins are muxed with GPIO and other functions	• Any LCD pin can be FP (segment) or BP (common), based on software configuration
On-Chip Memory	
• Up to 16 KB flash comprised of two separate arrays to facilitate read/program/erase over full operating voltage and temperature	• Allows you to take full advantage of operating voltage and temperature in-application reprogrammability benefits in virtually any environment
• 1.8V to 3.6V RAM	• Security circuitry prevents unauthorized access to RAM and flash contents, reducing system power consumption

Cost-Effective Development Tools

DEMO9S08LL16

$69*

Cost-effective demonstration kit includes the serial port and built-in USB-BDM cable for debugging and programming. This tool also has a lab that demonstrates the ultra-low-power benefits and LCD feature.

CodeWarrior™ Development Studio for Microcontrollers v6.2

Complimentary** Special Edition

CodeWarrior Development Studio for Microcontrollers is a suite of tools that supports software development for Freescale's 8-bit MCUs and 32-bit V1 ColdFire® devices. Designers can further accelerate application development with the help of Processor Expert™, an award-winning rapid application development tool integrated into the CodeWarrior tool suite.

* Prices indicated are MSRP
** Subject to license agreement

9S08LL16 Block Diagram

S08 Core	LVD	I^2C
Flash Size 16K Dual 8K Arrays	KBI	SCI
	COP	ICS
2K RAM	SPI	TOD
	Comparator	8-ch., 12-bit ADC
ICE + 08BDM	LCD Driver 8 x 24	2 x 2-ch. 16-bit Timer

Features, cont.	Benefits, cont.
Peripherals	
• Analog-to-digital converter (ADC)—8-channel, 12-bit resolution; 2.5 µs conversion time; automatic compare function; internal temperature sensor; internal bandgap reference channel; operation in stop mode	• Having eight channels allows up to eight analog devices to be sampled at extremely high speeds • Accuracy and full functionality guaranteed across 1.8V to 3.6V operating voltage of the MCU
• Timer—two 2-channel (TPM1 and TPM2); selectable input capture, output compare, buffered-edge or center-aligned PWM on each channel	• Two TPMs allow for two different time bases, with a total of twelve timer channels
• Serial communications interface (SCI)—module offering asynchronous communications,13-bit break option, flexible baud rate generator, double buffered transmit and receive and optional HW parity checking and generation	• Provides standard UART communications peripheral • Allows full-duplex, asynchronous NRZ serial communication between MCU and remote devices • Edge interrupt can wake up MCU from low-power mode
• Analog comparator with selectable interrupt on rising, falling or either edge of comparator output; compare option to fixed internal bandgap reference voltage; outputs can be optionally routed to TPM module; operation in stop3	• Requires only single pin for input signal, freeing additional pins for other use • Allows other components in system to see result of comparator with minimal delay • Can be used for single-slope ADC and RC time-constant measurements
• Serial peripheral interface (SPI)—one module with full-duplex or single-wire bidirectional; double-buffered transmit and receive; master or slave mode; MSB-first or LSB-first shifting	• Allows high-speed (up to 5 Mbps) communications to other MCUs or peripherals, such as MC1319x RF transceivers
• I^2C with up to 100 kbps with maximum bus loading; multi-master operation; programmable slave address; interrupt-driven byte-by-byte data transfer; supports broadcast mode and 10-bit addressing	• I^2C port enables increased system memory by using an additional I^2C EEPROM. This also creates an opportunity to add an additional I^2C device.
Input/Output	
• 38 general purpose input/output (GPIO), two output-only pins	• Results in large number of flexible I/O pins that allow developers to easily interface devices into their own designs
• Eight keyboard interrupt (KBI) pins with selectable polarity	• Can be used for reading input from a keypad or used as general pin interrupts
System Protection	
• Watchdog computer operating properly (COP) reset with option to run from dedicated 1 kHz internal clock source or bus clock	• Allows device to recognize runaway code (infinite loops) and resets processor to avoid lock-up states
• Low-voltage detection with reset or interrupt; selectable trip points	• Warns the developer of voltage drops outside of the typical operating range
• Illegal op code and illegal address detection with reset	• Allows the device to recognize erroneous code and resets the processor to avoid lock-up states
• Flash block protection	• Prevents unintentional programming of protected flash memory, which greatly reduces the chance of losing vital system code for vendor applications
Development Support	
• Single-wire background debug interface	• Allows developers to use the same hardware cables between S08 and V1 ColdFire platforms
• Breakpoint capability	• Allows single breakpoint setting during in-circuit debugging (plus three more breakpoints in on-chip debug module)
• ICE debug module containing three comparators and nine trigger modes. Eight deep FIFO for storing change-of-flow addresses and event-only data—debug module supports both tag and force breakpoints.	• Provides built-in full emulation without expense of traditional emulator

Learn More: For current information about Freescale products and documentation, please visit **www.freescale.com/lcd**.

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