



Freescale's Next Generation 8-bit LCD Solutions

When most consumers think of LCD, they probably envision a flat panel television or computer monitor. However, there are millions more LCDs out there that soldier on as highly effective data displays and human-machine interface devices that help make our lives more comfortable and productive. These applications include thermostats and small appliances for the home as well as exercise equipment, blood glucose meters and blood pressure monitors to help improve personal health.

These kinds of embedded LCDs require small yet powerful and extremely energy efficient microcontrollers (MCUs) with LCD drivers. In addition to energy efficiency, the modern rendition of LCD technology must be low cost, include a rich peripheral set and provide an updated LCD driver with compelling features.

Introducing the L family of MCUs

Freescale has introduced the L family of 8-bit MCUs with LCD drivers to address these applications and to provide an LCD-enabled platform designers can use for new and even more exciting innovations. The software configurable LCD driver module can drive more segments with fewer pins, eliminating the need for a separate display driver chip and enabling smaller connectors and a smaller product footprint.

Some of the advanced features within the L family include flexible pin reassignments for LCD signals, low-power blinking mode, alternate display capabilities and a regulated charge pump. The family includes products based on both the S08 and RS08 cores, providing designers with a wide range of 8-bit capabilities to exactly fit their application requirements.

Energy efficiency

Freescale's first 8-bit S08 device with an integrated LCD driver module is the MC9S08LL16 MCU. It incorporates Freescale's latest energy efficient design techniques to bring high performance LCD technology to small, portable devices and entry-level consumer and industrial applications.

- **Ultra-low power** – Two ultra-low-power stop modes (as low as 1.8 μ A with all segments on) extend battery life by allowing key peripherals, such as LCD and ADC, to remain on while in low-power modes. The LL16 also incorporates new low-power run and wait modes that allow the use of all chip peripherals in a low-power state.
- **6 μ s typical wake-up from stop mode** – This enables faster execution out of stop mode. The time the MCU operates in its higher-power-consuming active state is kept at a minimum.
- **Internal clock source (ICS) module** – This contains a frequency-locked loop (FLL) that is controlled by an internal or external reference. This allows the user to choose frequencies on the fly, with lower frequency options available on demand to save power.
- **Ultra-low-power oscillator (OSC)** – This provides an accurate time base in low-power modes.
- **Clock gating** – This is an architectural technique that is an effective strategy used to help reduce power consumption while maintaining the same levels of performance and functionality. A circuit uses more power when it's being clocked than when the clock is gated, or turned off. Sizable energy savings can be realized by shutting off the clocks and stopping the toggling of data in unused portions of the semiconductor. The energy savings are particularly significant when the gating is engineered to control the toggling at the individual instruction level.

Lower cost

Freescale's RS08 core products have been specifically crafted to be more efficient and cost effective for small memory size MCUs. To create the RS08 core, the engineers at Freescale have removed from the S08 core those functions that are not required for ultra-low-end applications and have enhanced the remaining operations to improve the efficiency of extremely small controllers. The result is a core thirty percent smaller than the S08 core that is optimized for cost-effective, space efficient operations.

The first RS08 cost-effective MCUs with LCD drivers are the MC9RS08LA8 and MC9RS08LE4 devices. They are intended for small appliances, medical equipment and other industrial and multi-market applications. From the extremely low cost RS08LA8 and RS08LE4 products to the ultra-low-power S08LL16 MCU, Freescale offers a broad range of economical LCD solutions for thousands of mid-range and entry-level applications. Users can reduce BOMs without sacrificing functionality.

Feature rich

L-family MCUs feature large segment-based (8x mode) LCD drivers and integrated charge pumps to provide true system-on-chip functionality. Additional feature include:

- On-chip analog-to-digital converters (ADCs), which can operate in stop mode, provide 2.5 μ s conversion time. With up to eight channels, as many as eight analog devices can be sampled at extremely high speeds.
- Two timer modules (TPM1 and TPM2) enable two different time bases with a total of twelve timer channels (LL16 and LE4 only).
- Serial communications interface (SCI) allows full-duplex, asynchronous, NRZ serial communication between the MCU and remote devices with edge interrupt to wake up the MCU from low-power mode.
- Analog comparator with selectable interrupt on rising, falling or either edge of the comparator output requires only a single pin for the input signal, freeing additional pins for other uses.

- Serial peripheral interface (SPI) allows high-speed (up to 5 Mbps) communications to other MCUs or peripherals, such as RF transceivers.
- A large number of general purpose input/output (GPIO) pins – 38 (LL16), 33 (LA8) and 26 (LE4) – allow developers to easily interface devices to their own designs.
- A variety of system protection functions, such as watchdog computer operating properly (COP), low-voltage detection, flash block protection and illegal op code and illegal address detection with reset.

Refreshing the LCD peripheral

Freescale has “refreshed” the LCD peripheral for the L-family MCUs to provide developers with more design options. The resulting module is a more flexible, more reliable and more energy efficient LCD driver.

Driving up to eight backplanes – All L-family member LCD modules can drive up to eight backplanes.

- LL16: 8x24 or 4x28
- LA8: 8x21 or 4x25
- LE4: 8x14 or 4x18

Providing this kind of flexibility allows developers to drive more segments with fewer pins. The reduced package size allows a smaller, more cost effective board design with lower electromagnetic interference (EMI).

Example – You have been asked to redesign a 160 segment LCD application into a smaller footprint. Normally, you would need 80 pins to support a 160 segment operation. However, Freescale’s L family integrates an 8x mux device, which means you can use a 48-pin L-family device to drive 160 segments. Essentially, you’re trading a 12 x 12 device for a 10 x 10 device. The resulting PCB is smaller and lower cost with a reduced number of signals that need routing, which improves EMI performance.

There are other design options that can be addressed through 8x muxing. For instance, you can add more segments yet still keep the size and costs low. With a 64-pin L-family MCU you could drive 192 segments, which would allow two more 16-segment alpha-numeric characters. Overall, the L family allows designers to create a higher mix of LCD numbers, text and icons as well as enabling scrolling text and simple displays.

Flexible pin reassignment – L-family pins can be assigned as either backplane (BP) or frontplane (FP), and they can be interchanged as the designer sees fit. Not only can this lower system cost by simplifying PCB layout, but the designer can also assign shorter signal paths between the MCU and the LCD glass, which helps reduce EMI.

Example – New customer requests have dictated that you need to update the look of the LCD glass in your application. Unfortunately, the changes require a different pin out. Instead of having to rewire the board, using a member of the L family allows you to keep the same layout, including all the interconnects, by simply using software to reassign the pins. There are three major benefits to this method:

- Because any pin can be either BP or FP, board layout is simplified with shorter interconnects. This means development time and costs are reduced and any changes in the pin configuration can be accomplished without any hardware redesign.
- The shorter interconnects allow developers to explore different options for improved EMI.
- It simplifies migrating from entry-level LCDs to more intricate designs. In other words, the designer can consider different LCD segment requirements using the same chip.

Regulated charge pump – On the S08LL16, a regulated charge pump keeps the same power across the LCD glass regardless of the input power. This improves the user experience and extends the usable lifetime of the device. It is particularly welcome in battery-powered applications, since the LCD screen remains constant, avoiding visual degradation and flickering, even as the battery drains down. The regulated charge pump also allows that all LCD glass voltages can be generated from a common voltage input. The regulated charge pump is also useful for contrast control.

Example – Running a constant contrast in a portable device doesn't need to remain "constant," so to speak. Different operating conditions can demand different contrast levels for optimum LCD viewing. With the regulated charge pump, the developer or even the user can adjust the contrast via on-board software. For instance, this can be a particularly valuable function in changing ambient light conditions.

Low-power blinking mode – All L-family devices support a low-power blinking mode that doesn't require CPU intervention. This can lower power consumption over the life of the battery, and it can be particularly beneficial in applications that feature a continuous blinking function.

Example – Many digital watches today feature a blinking second count. Normally, each blink would require a CPU wake-up followed by a short sleep period between each blink. Low-power blinking mode eliminates the energy-consuming wake/sleep cycle by allowing the CPU to remain in sleep mode. The mode can also be used as a low-power method for indicating continuous operation in applications like security systems.

Alternate display – L-family devices also have the ability to blink between two alternate displays (in 4x mode or less) without waking up the CPU. This enables applications to continuously alternate between two information displays, such as time and temperature, while remaining in low-power mode.

Conclusion

The industry trend is moving from 4x to 8x mode segmented LCDs to display more information. The market is also expanding into new arenas that demand solutions with lower power consumption and smaller footprints, which enable LCD technology to be integrated into portable or space-constrained applications. Freescale's L-family solutions are cost-effective, energy-efficient alternatives that offer 8-bit performance and refreshed 8x mode segmented LCD drivers for next generation applications.

Demonstrating an emphasis on ultra-low-power performance, the S08LL16 is a Freescale Energy Efficient Solutions product, having less than 50 percent the current draw of previous generation Freescale parts. Whereas all L-family MCUs exhibit outstanding energy efficiency, the power management technologies implemented in the LL16 present a truly optimal energy efficient solution that will deliver exceptional performance within a specified energy budget over the life of the application.



For more information about the Freescale L-family of 8-bit MCUs, please visit our LCD Microcontrollers web page at www.freescale.com/lcd.

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