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Eliminating Segment LCD module Ghosting

MCUs using the segment LCD module may experience segment ghosting

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1 Brief Description

When LCD segments are driven by MCUs with an LCD module, “ghosting” may occur when the LCD module is disabled. Ghosting is the momentary darkening of a subset of LCD segments.

2 Detailed Description

On some devices front-plane output pins on an MCU with the segment LCD module can drift high after the LCD module enable is cleared. The voltage difference between the front-plane and back-plane pins of the LCD segment results in a temporary “opacity” or “darkening” of segments on the LCD glass. This phenomenon is commonly called "ghosting." Ghosting can occur on pins with LCD functional pads, for example both LCD-only pins and LCD pins that shared functionality with GPIO.

After the LCD module is disabled by the user code, the LCD module releases control over the pin. The pin then becomes a high impedance node. The pin voltage in a high impedance state can drift high or low. The predominant behavior of a pad connected to the LCD glass is to discharge to a voltage near ground effectively de-activating the segment.

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A ghosting LCD pin drifts high after the LCD module is disabled. The voltage potential difference created between the front-plane and back-plane results in the segments of that front-plane ghosting for a short time. The time is determined by the amount of load on the LCD pin. For this reason most user will not ever see this phenomenon. Some segments may show momentarily dark, then fade out as the voltage potential of the pin is bled off through the load of the LCD display. It has been observed that applications with smaller LCD glass tend to ghost for longer times because of the smaller load.

3 Solutions

There are a few solutions depending upon the type of LCD output pin being used and the MCU.

If possible, do not disable the LCD module. The LCD segments will not ghost if the LCD module actively drives the segment off. Simply clearing the front plane buffer will drive the LCD with an 'off' waveform. Having the LCD module enabled consumes slightly more current, however, it is typically only about a 1µA adder. For the worst case current adder, see the MCU data sheet.

If you must disable the LCD module for power considerations, you have two options. First, a software solution is available for LCD pins that have shared functionality with GPIO. Second, for pins that are LCD-only pins, there is currently only a hardware solution available.

1. **Software solution for devices that have LCD pins sharing functionality with GPIO**—You enable the pull device and set the pull device low. Once, for each of the pins being used for LCD segment drivers, write initialization code to set the pull-up-enable bits (PUE) to equal 1 and leave the pull-up-select bits (PUS) equal to 0. This has the effect of actively pulling the pins low when the LCD module releases control over the pad logic. For S08 and ColdFire V1 devices, the pads revert back to GPIO when the LCD module is disabled. For Kinetis devices however, you must actively change the pin control registers to select the GPIO function for each of the LCD pins before disabling the LCD module. This operation has the effect of driving the pin to a low state, eliminating the possible ghosting effect.
2. **Hardware solution for S08 and ColdFire V1 devices that have LCD-only pins**—The only way to keep an LCD segment from ghosting, other than not disabling the LCD module, is to add an external load to ground (i.e. a 10MΩ resistor to ground). The resistance is high enough not affect the LCD waveform but effective in driving the pin low when the LCD module is disabled. Please consider the power implications of this before using this method. Depending upon the frame rate and duty cycle of these pins, this may result in a higher average current for the circuit. The average current may be less if you just left the LCD module enabled, eliminating the need for the pull-down resistors.

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