Custom LCD differentiation: Not as hard as you might think

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Custom LCD displays can wildly differentiate your products from the competition leading to greater sales and adoption by your customers or even lower your manufacturing costs. Implementing custom displays, however, increases design complexity and, with the wrong solution, may negatively offset the cost savings in manufacturing. In this article we'll explore the advantages of custom LCD designs and what they mean to your products as well as an approach to mitigating design complexity and cost through the use of system-level programmable solutions.

Advantages of Custom LCD Displays

The advantages of custom LCD displays over traditional LCD modules include the ability to differentiate your products without compromise as well as the reduction in manufacturing costs. The use of custom LCD glass for your products enables you to display what matters to your product and to your customers much more than compromising the display for what LCD modules might be available. As an example, a bedside alarm clock could provide much more information to its user versus just a digital display of the time. Through the use of custom glass the alarm clock could also be designed such that you could display the time, in possibly a variety of formats; the date, also in a variety of formats; as well as custom and cleaner displays of the day of the week, a calendar, scrolling messages such as traffic, alerts and other data that is typically transmitted alongside radio station broadcasts, etc. This method of differentiating your product from the competition can be applied to practically any application that utilizes LCD displays.

One of the other significant advantages of LCD glass versus LCD modules is cost. LCD glass, when purchased in volume, can be a significant cost saver versus modules with integrated LCD drive ICs. Any product you're working on that has an LCD display more than likely also has some or many MCUs within performing the functions that the product is supposed to do. By integrating the LCD drive capability within the MCU performing those critical product functions you can reduce your manufacturing cost associated with those more expensive LCD modules. You will pay an upfront non-recurring engineering cost to design the custom LCD glass, but in volume, that cost is easily amortized across such that the true cost of the LCD glass is significantly lower than the per unit cost of an LCD module—this could be as much as $3 of BOM cost savings per unit! In production volumes of 1k or more, this is significant and should be greatly considered.

Number of Segments and Commons

When trying to differentiate an end product, the complexity of the LCD can play a big role in that. The more custom symbols and numerical or alphanumeric digits used, the easier it is to convey information to the user like, menus, settings, and readings. For example, there is a big difference in the information that can be conveyed from 4 seven-segment numeric displays and 8 fourteen-segment alphanumeric displays. With one you can only display numbers (time, measurements), and with the other you can display modes, text, errors, directions, on top of numbers. Figure 1 shows an example of a complex custom LCD display that can be used to show many modes, configuration, errors and other information.

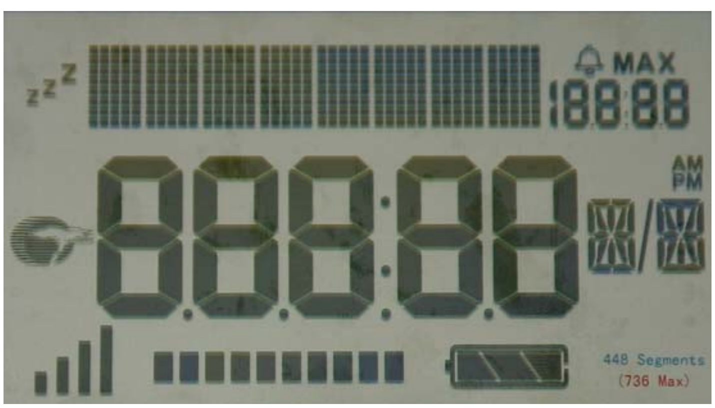


Figure 1 - Complex Custom LCD

Adding alphanumeric digits, and more of them, does not come without a cost, but there are ways to mitigate that cost. Start with an example of two LCDs: LCD 1 has 4 seven-segment displays where 28 pixels needed and LCD 2 has 8 fourteen-segment displays where 112 pixels needed. LCDs are driven such that each pixel lives at the intersection of a segment pin and a common pin that is driven by an MCU or an LCD driver chip. Generally a common pin will be connected to many more pixels than a segment pin, and thus represent a much higher load; seen in Figure 2. Every MCU will spec a maximum number of common pins, and almost all of them max out at 4. So back to the example the two LCDs, if an MCU has four commons then it will need 7 segment lines to drive the 28 pixels in LCD 1 and 28 segment lines to drive the 112 pixels in LCD 2, refer to Figure 2. That is an increase from 11 total pins for LCD 1 to 32 pins for LCD 2. Those extra 21 pins can force the design into a larger package for the MCU or into an external driver all together, thus increasing the cost of the design.

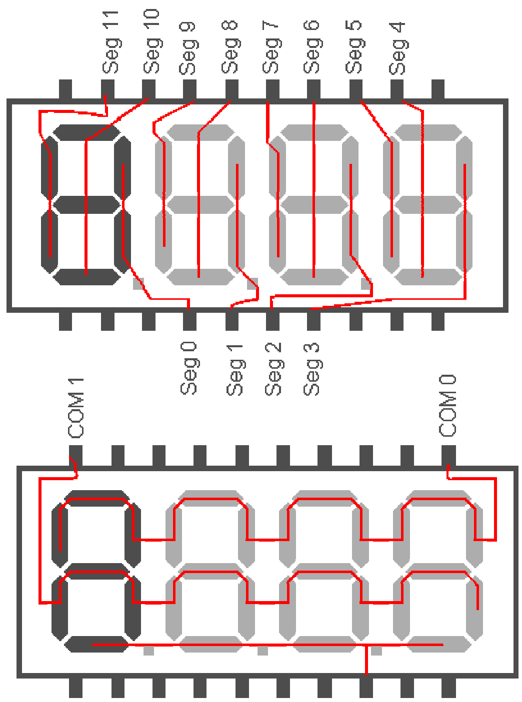
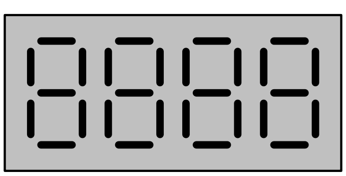


Figure 2 - Segment and Common Pin Connections in an LCD

The way to avoid this cost increase is to select an MCU which can drive more commons than 4. Look at LCD 2 which requires 32 pins when the MCU can only drive 4 commons. If the MCU can drive 8 commons only 22 pins are needed. That is a savings of 10 pins just by selecting an MCU with the right LCD drive feature set. See the breakdown in Figure 3.

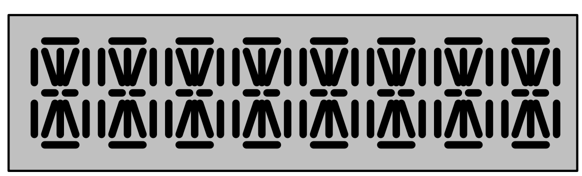
LCD 1



7 Segment X 4 = 28 Pixels

Commons	Segments	Total Pins
2	14	16
4	7	11
6	5	11
8	4	12

LCD 2



14 Segment X 8 = 112 Pixels

Commons	Segments	Total Pins
2	56	58
4	28	32
8	14	22
16	7	23

Figure 3 - Custom LCD Comparison

Flexible routing and I/Os

Another factor in selecting the right MCU to enable you to realize the advantages of custom LCD glass over LCD modules is the availability and flexibility of LCD Drive I/O within the MCU. Traditional MCU vendors typically provide LCD Drive as an option within their portfolios. In addition to the number of segments and commons supported by a given vendor's LCD Drive-enabled MCU, you need to investigate what pins around a given package and how the locations of those pins may affect your system-board design. The more spread out these pins, the more complex your PCB layout will be.

A different approach made possible with a few revolutionary embedded system ICs in the market today make this part of driving custom LCD glass as easy as interfacing to an LCD module. Specifically, programmable embedded systems, such as Cypress's PSoC programmable system-on-chip, enable you to utilize any of the general purpose I/O across the device as analog, digital or LCD Drive I/O—on the larger I/O devices this equates to supporting 736-pixels on large LCD glass displays. And the ability to pick and choose the pins you want allows you to cut PCB complexity and costs by optimizing the routes of these LCD drive signals across your application.

Debug and driving an LCD glass

Another potential complexity to adding a custom glass to a product is the additional firmware needed to control the display. It may seem that because each display is custom that it will require ground up coding to actually communicate to the display. The truth is that there are commonly used characters (seven-segment, 14-segment, dot matrix), symbols (plus sign, AM/PM, decimal, colon) and groups of symbols (bar graphs, battery indicators). With these commonalities in custom LCD design, MCU vendors have come up with many ways to make the coding and even the debug process easier than ever.

For characters such as seven-segment, fourteen-segment, and dot matrix, there needs to be a translation between the desired character that is expressed in the code and which pixels are on and off to create that character. For example, if the number '8' is supposed to be displayed on a seven-segment display, there needs to be some piece of code that takes and input of '8' and turns on all of the pixels of the character on the LCD to display an '8'. Usually this is done using a lookup table. Creating these lookup tables for alphanumeric characters can be very time consuming and prone to making errors. That is why many MCU vendors will provide lookup tables that can be used in the designs which will handle number and letter creation.

For symbols and groups of symbols, it is usually up to the designer to create their own code to describe the behavior. This is because a symbol is usually just an on or off indicator so that is easy. A group of symbols that are related, such as a bar graph and battery indicator, are highly custom to the design so usually it is up to the designer to define their relationship on their own.

Another step that can be time consuming to design and debug is the mapping of each pixel to a specific segment and common pin output from the MCU. This must all reside in memory and is sometimes input as big array. The difficulty comes when trying to keep all the pixels strait when they are in an array form. This can also lead to a debugging nightmare when certain pixels don't seem to turn on and off the way you anticipate them to. There again some MCU vendors have created GUIs, like the PSoC Creator GUI from Cypress Semiconductor in Figure 4, which allow the designer to map the pixels they way they appear on the datasheet of the glass. In the same GUI the designer can define the relationship of groups of pixels (as a character or bar graph) and then create code and APIs which the designer can use their design. These tools make designing with a custom LCD a breeze and eliminate the hassle of chasing down that one pixel that is defined incorrectly.

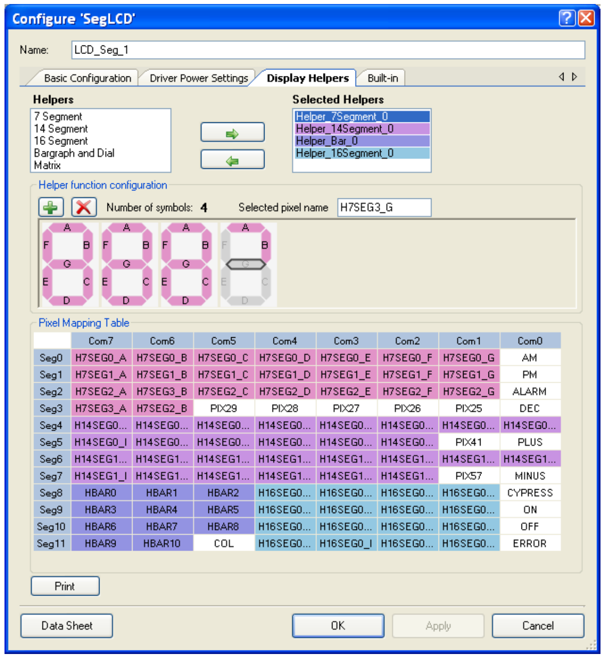


Figure 4 - LCD Configuration GUI

Conclusion

One of the best ways to differentiate your product from your competition is by integrating a custom LCD into your application. The addition of alphanumeric characters, symbols, and even product logos can give your application a professional look and a feel of simplicity that consumers look for. With the features and tools provided by MCU manufacturers and especially companies like Cypress and the PSoC programmable system-on-chip, adding a complex custom LCD can be developed and integrated into your design with minimal additional engineering effort and cost.

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