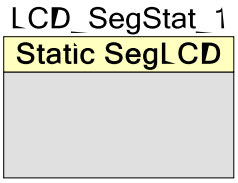
Static Segment LCD (LCD_SegStat) 1.10

Features



- 1 to 61 pixels or symbols
- 10 to 150 Hz refresh rate
- User-defined pixel or symbol map with optional 7 segment, 14 segment, 16 segment and bar graph calculation routines.

General Description

The Static Segment LCD (LCD_SegStat) component can directly drive 3.3V and 5.0V LCD glass. This component provides an easy method of configuring the PSoC device for your custom or standard glass.

Each LCD pixel/symbol may be either on or off. The Segment LCD component also provides advanced support to simplify the following types of display structures within the glass:

- 7 Segment numerals
- 14 Segment alphanumeric
- 16 Segment alphanumeric
- 1-255 element bar graphs

The LCD is configurable to optimize power in portable applications and provides display updates in sleep modes.

When to use a Static Segment LCD

Use the Static Segment Drive LCD component when you need to directly drive 3.3V or 5.0V LCD glass in a static mode (for glass configurations that have only one common line). The Static Segment LCD component does not require the target PSoC device to provide LCD drive hardware resources. The component can be used on any target chip that has sufficient pins to support the required number of common and segment lines.

Input/Output Connections

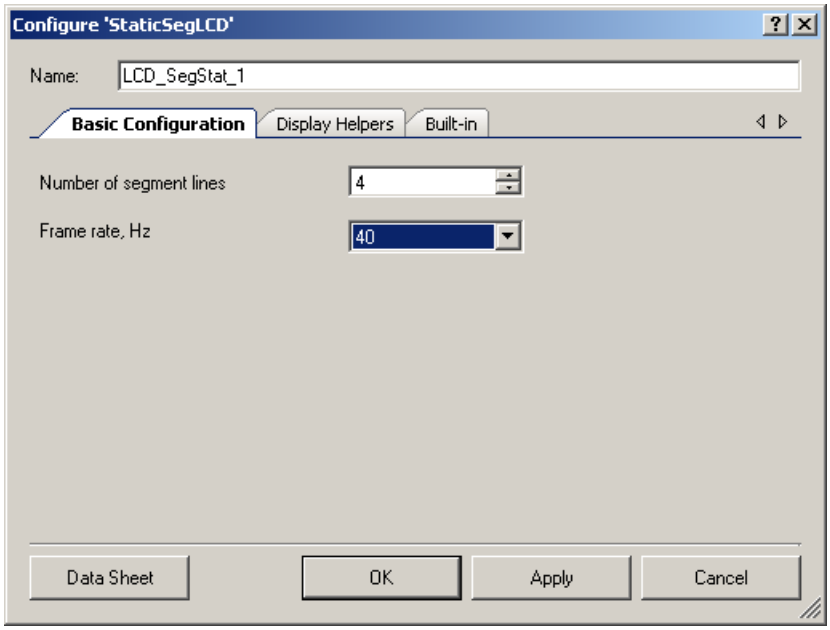
Not applicable

PRELIMINARY

Parameters and Setup

Drag a Static Segment LCD component onto your design and double-click it to open the Configure dialog.

Basic Configuration Tab



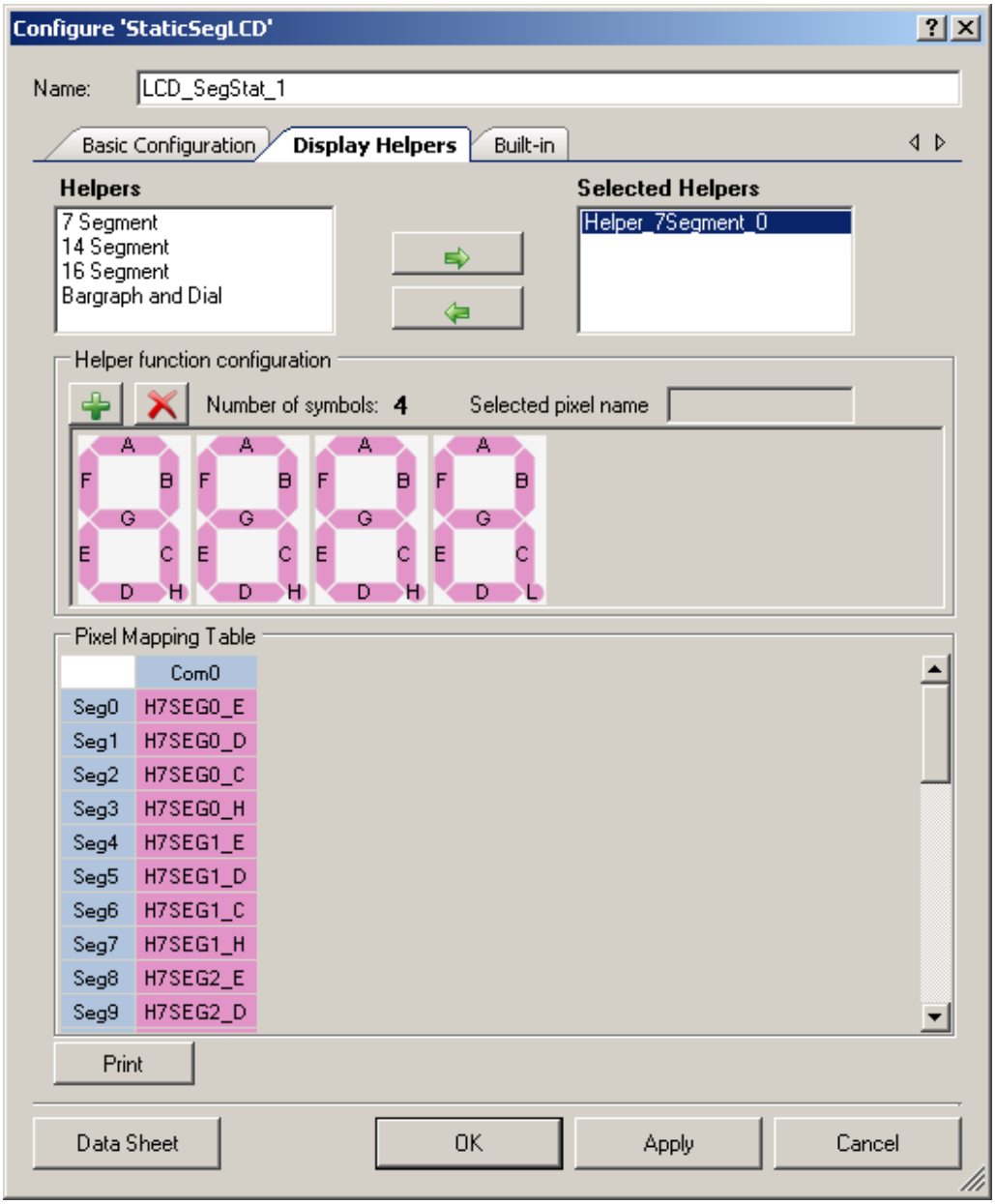
Number of Segment Lines

Defines the number of segment lines in the user-defined display. The default is 4.

Frame Rate

Determines the refresh rate of the display. Possible values include 10Hz to 150Hz. The default is 30Hz.

Display Helpers Tab



Display Helpers allow you to configure a group of display segments to be used together as one of several predefined display element types: 7, 14, or 16 segment displays or a linear or circular bar graph display. The character based display helpers can be used to combine multiple display symbols in one display helper to create multi-character display elements.

Helpers / Selected Helpers

You may add one or more helpers to the **Selected Helpers** list by selecting one in the **Helpers** list and clicking the right-arrow button. If there are not enough pins to manage a new helper, it

will not be added. To delete a helper, select it in the **Selected Helpers** list and click the left-arrow button.

Note: Once you have added a Display Helper to the component, you will not be able to change the number of common and segment lines. So it is important to set the number of common and segment lines first. If you do want to change the number of common and segment lines, you will have to remove the helpers.

The order in which the **Selected Helpers** appear in the list has meaning. The first **Selected Helper** of a specific type added first is marked with index 0, the next one of the same type is marked with index 1, and so on. If a **Selected Helper** is removed from the list, the following indexes move up, but retain their index number. If you add another index, it will obtain the first available index.

Helper Function Configuration

This section of the dialog allows you to configure a helper, which includes adding and removing symbols to the helper as well as renaming pixels.

1. Select a helper from the **Selected Helpers** list.
2. Click the [+] or [x] button to add or remove a symbol for the selected helper.

   The maximum number of symbols you may add depends on the helper type and the total number of symbols supported by the component. If the number of available pins is not enough to manage a new symbol, it will not be added.
3. To rename a pixel, select it in the LCD image and the name will display in the **Selected pixel name** field.

   The name includes two parts: a prefix and a unique name. The prefix includes a display number, helper type, and symbol number. It is common for all pixels in the symbol. The last part is a unique name of the pixel in the symbol.

   If a prefix is not changed, the pixel name shown on the symbol includes only the unique name. If else, the full name would be displayed. The names of all pixels must be unique.

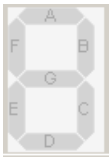
Pixel Mapping Table

The pixel mapping table is a representation of the Frame Buffer. For correct work of API functions added by Helper functions you need to assign pixels from Helper Function Configuration to pixels in the Pixel mapping table. In other words you need to locate helper function pixel in the frame buffer. You will need a datasheet of your LCD glass also to make correct pin assignment. To assign pixels just select desired pixel in the Helper Function Configuration panel and drag it to the Pixel Mapping Table and drop in the position defined in LCD glass specs.

The **Print** button prints a pixel mapping table

7 Segment helper

The 7 Segment Helper may be 1 to 5 digits in length and can display either hexadecimal digits 0 to 15 (0 to F) or 16-bit unsigned integer (uint16) values. The decimal point is not supported by the helper function. The decimal point, if required, should be handled in software. APIs are provided for each helper. Refer to API section for more information.



14 Segment helper

The 14 Segment Helper may be up to 20 characters in length. The 14 segment helper displays a single ASCII character or a null terminated string. Possible values are standard ASCII printable characters (with codes from 0 to 127). APIs are provided for each helper. Refer to API section for more information.

16 Segment helper

The 16 Segment Helper may be up to 20 characters in length. The 16 segment helper may display possible single ASCII characters or a complete null terminated string. Possible values are standard ASCII characters and table of extended codes (with codes from 0 to 255). A table of extended codes is not supplied. APIs are provided for each helper. Refer to API section for more information.

Bargraph and Dial helper

The Bargraph Helper is used for bar graphs and dial indicators with 1 to 255 segments. The bargraph may be a single selected pixel or the selected pixel and all pixels to the left or right of the selected pixel. Possible values are 0-255 with zero representing all pixels off. APIs are provided for each helper. Refer to API section for more information.

Clock Selection

Segment LCD component uses two internal clocks and does not require an external clock. Once the component is placed, the two clocks are automatically dedicated to the LCD component. The first clock generates input frequency and the second generates a 100 KHz clock for the Low Drive buffers.

Placement

Default pin assignments are made during the build process and can be modified using the Pin Editor in the PSoC Creator Design Wide Resources tool.

Resources

Digital Blocks					API Memory (Bytes)		
Datapaths	Macro cells	Status Registers	Control Registers	Counter7	Flash	RAM	Pins (per External I/O)
0	0	0	0	0	?	?	2 - 62

Application Programming Interface

Application Programming Interface (API) routines allow you to configure the component using software. The following table lists and describes the interface to each function. The subsequent sections cover each function in more detail.

By default, PSoC Creator assigns the instance name "LCD_SegStat_1" to the first instance of a component in a given design. You can rename the instance to any unique value that follows the syntactic rules for identifiers. The instance name becomes the prefix of every global function name, variable, and constant symbol. For readability, the instance name used in the following table is "LCD_SegStat".

Function	Description
LCD_SegStat_Start	Starts the LCD component and enables any required interrupts, DMA channels frame buffer and hardware. Does not clear the frame buffer SRAM if previously defined.
LCD_SegStat_Stop	Disables the LCD component and disables any required interrupts and DMA channels. Automatically blanks the display to avoid damage from DC offsets. Does not clear the frame buffer
LCD_SegStat_EnableInt	Enables the LCD interrupt/s. Not required if Start called
LCD_SegStat_DisableInt	Disables the LCD interrupt. Not required if Stop called

Function	Description
LCD_SegStat_ClearDisplay	This function clears the display RAM of the frame buffer.
LCD_SegStat_WritePixel	This function sets or clears a pixel based on PixelState in a frame buffer. The Pixel is addressed by a packed number. User code can also directly write the frame buffer RAM to create optimized interactions.
LCD_SegStat_ReadPixel	This function reads a pixels state in a frame buffer. The Pixel is addressed by a packed number. User code can also directly read the frame buffer RAM to create optimized interactions.
LCD_SegStat_Write7SegDigit_n	This function displays a digit on a 7 segment display element. Digits can be hexadecimal values in the range of 0-9 and A-F. A 7 segment display helper must have been configured in the customizer to define which display segments make up the 7 segment element(s). Multiple, 7 segment displays can be created in the frame buffer and are addressed through the index (n) in the function name. This function is only available if a 7 segment display element is defined in the component customizer.
LCD_SegStat_Write7SegNumber_n	This function displays an integer value on a 1 to 5 digit 7 segment display. You must define what portion of the displays segments make up the 7 segment display portion In the customizer. Multiple, separate 7 segment displays can be created in the frame buffer and are addressed through the index (n) in the function name. Function/s only included if component 7 segment customizer defines the 7 segment option. Sign conversion, sign display, decimal points and other custom features must be handled by application specific user code.
LCD_SegStat_WriteBargraph_n	This function displays an integer value on a linear or circular bar-graph The bar graph may be any user-defined size between 1 and 255 segments using a customizer display helper.
LCD_SegStat_PutChar14Seg_n	This function displays a character on a 14 segment alphanumeric character display. You must define what portion of the displays segments make up the alphanumeric display portion in the customizer. Multiple, separate alphanumeric displays can be created in the frame buffer and are addressed through the index (n) in the function name. Functions are only included if the component alphanumeric customizer defines the alphanumeric option.
LCD_SegStat_WriteString14Seg_n	This function displays a null terminated character string on a set of 14 segment alphanumeric character displays. You must define what portion of the displays segments make up the alphanumeric display portion in the customizer. Multiple, separate alphanumeric displays can be created in the frame buffer and are addressed through the index (n) in the function name. Functions are only included if the component alphanumeric customizer defines the alphanumeric option.

Function	Description
LCD_SegStat_PutChar16Seg_n	This function displays a character on a 16 segment alphanumeric character display. You must define what portion of the displays segments make up the alphanumeric display portion in the customizer. Multiple, separate alphanumeric displays can be created in the frame buffer and are addressed through the index (n) in the function name. Functions are only included if the component alphanumeric customizer defines the alphanumeric option.
LCD_SegStat_WriteString16Seg_n	This function displays a null terminated character string on a set of 16 segment alphanumeric character display symbols. You must define what portion of the displays segments make up the alphanumeric display portion in the customizer. Multiple, separate alphanumeric displays can be created in the frame buffer and are addressed through the index (n) in the function name. Functions are only included if the component alphanumeric customizer defines the alphanumeric option.

Note: Function names that contain a suffix “n” indicate that multiple display helpers of the same symbol type were created in the component customizer. Specific display helper elements are controlled by the API functions with the respective “n” index value in the function name.

uint8 LCD_SegStat_Start (void)

Description: Starts the LCD component and enables any required interrupts, DMA channels, frame buffers, and hardware. Does not clear the frame buffer SRAM if previously defined. Sign conversion, sign display, decimal points and other custom features must be handled by application specific user code.

Parameters: None

Return Value: (uint8) cystatus: Standard API return values.

Return Value	Description
CYRET_BAD_PARAM	One or more parameters to the function were invalid
CYRET_SUCCESS	Function completed successfully

Side Effects: None

void LCD_SegStat_Stop(void)

Description: Disables the LCD component and disables any required interrupts and DMA channels. Automatically blanks the display to avoid damage from DC offsets. Does not clear the frame buffer.

Parameters: None

Return Value: None

Side Effects: None

void LCD_SegStat_EnableInt(void)

Description: Enables the LCD interrupts. Not required if LCD_SegStat_Start is called.

Parameters: None

Return Value: None

Side Effects: None

void LCD_SegStat_DisableInt(void)

Description: Disables the LCD interrupts. Not required if LCD_SegStat_Stop is called.

Parameters: None

Return Value: None

Side Effects: None

void LCD_SegStat_ClearDisplay(void)

Description: This function clears the display RAM of the page buffer.

Parameters: None

Return Value: None

Side Effects: None

uint8 LCD_SegStat_WritePixel(uint16 PixelNumber, uint8 PixelState)

Description: This function sets or clears a pixel in the frame buffer based on the PixelState paramater. The Pixel is addressed with a packed number.

Parameters: (uint16) PixelNumber: is the packed number that points to the pixels location in the frame buffer. The lowest three bits in the LSB low nibble are the bit position in the byte, the LSB upper nibble (4 bits) is the byte address in the multiplex row and the MSB low nibble (4 bits) is the multiplex row number.

(uint8) PixelState: The PixelNumber specified is set to this pixel state. Symbolic names for the pixel state are provided, and their associated values are shown here:

Value	Description
LCD_SegStat_PIXEL_STATE_OFF	Set the pixel to off.
LCD_SegStat_PIXEL_STATE_ON	Set the pixel to on.
LCD_SegStat_PIXEL_STATE_INVERT	Invert the pixel's current state.

Return Value: (uint8) Status returns the standardized return value for pass or fail on a range check of the byte address and multiplex row number. No check is performed on bit position.

Side Effects: None

uint8 LCD_SegStat_ReadPixel(uint16 PixelNumber)

Description: This function reads a pixel's state in the frame buffer. The Pixel is addressed by a packed number.

Parameters: uint16: PixelNumber: is the packed number that points to the pixels location in the frame buffer. The lowest three bits in the LSB low nibble are the bit position in the byte, the LSB upper nibble (4 bits) is the byte address in the multiplex row and the MSB low nibble (4 bits) is the multiplex row number

Return Value: (uint8) PixelState: Returns the current status of the PixelNumber specified.

Value	Description
0	The pixel is off.
1	The pixel is on.

Side Effects: None

void LCD_SegStat_Write7SegDigit_n(uint8 Digit, uint8 Position)

Description: This function displays a 4-bit Hex digit in the range of 0-9 and A-F 7 segment display. You must define what portion of the displays segments make up the 7 segment display portion in the component customizer. Multiple, separate 7 segment displays can be created in the frame buffer and are addressed through the index (n) in the function name. Function/s only included if component 7 segment customizer defines the 7 segment option.

Parameters: (uint8) Digit: unsigned integer value in the range of 0 to 15 to be displayed as a hexadecimal digit.

(uint8) Position: Position of the digit as counted right to left starting at 0 on the right. If the defined display does not contain a digit in the Position then the digit will not be displayed.

Return Value: None

Side Effects: None

void LCD_SegStat Write7SegNumber_n(uint8 Value, uint8 Position, uint8 Mode)

Description: This function displays a 16-bit integer value on a 1 to 5 digit 7 segment display. You must define what portion of the displays segments make up the 7 segment display portion In the customizer. Multiple, separate 7 segment displays can be created in the frame buffer and are addressed through the index (n) in the function name. Function/s only included if component 7 segment customizer defines the 7 segment option.
Sign conversion, sign display, decimal points and other custom features must be handled by application specific user code.

Parameters: (uint8) Value: The unsigned integer value to be displayed.

(uint8) Position: The position of the least significant digit as counted right to left starting at 0 on the right. If the defined display contains fewer digits then the Value requires for display for the most significant digit or digits will not be displayed

(uint8) Mode: Sets the display mode. Can be zero or one.

Value	Description
0	No leading 0s are displayed.
1	Leading 0s are displayed

Return Value: None

Side Effects: None

void LCD_SegStat_WriteBargraph_n(uint8 Location, uint8 Mode)

Description: This function displays an 8-bit integer Location on a 1 to 255 segment bar-graph (numbered left to right).The bar graph may be any user-defined size between 1 and 255 segments. A bar graph may also be created in a circle to display rotary position. You must define what portion of the displays segments make up the bar-graph portion. Multiple, separate bar graph displays can be created in the frame buffer and are addressed through the index (n) in the function name. Function/s only included if component bar-graph customizer defines the 7 segment option

Parameters: (uint8) Location: The unsigned integer Location to be displayed. Valid values are from zero to the number of segments in the bar graph. A zero turns all bar-graph elements off. Values greater than the number of segments in the bar-graph result in all elements on.

(uint8) Mode: Sets the bargraph display mode.

Value	Description
0	Only the Location segment is turned on
1	The Location segment all segments to the left are turned on
–1	The Location segment and all segments to the right are turned on.
2-10	Display the Location segment and 2-10 segments to the right to create wide indicators.

Return Value: None

Side Effects: None

void LCD_SegStat_PutChar14Seg_n(uint8 Character, uint8 Position)

Description: This function displays an 8-bit char on an array of alphanumeric character displays. You must define what portion of the displays segments make up the alphanumeric display portion in the customizer. Multiple, separate alphanumeric displays can be created in the frame buffer and are addressed through the index (n) in the function name. Functions are only included if the component alphanumeric customizer defines the alphanumeric option.

Parameters: (uint8) Character: The ASCII value of the character to display.

(uint8) Position: Position of the character as counted left to right starting at 0 on the left. If the position is outside the display range, the character will not be displayed.

Return Value: None

Side Effects: None

void LCD_SegStat_WriteString14Seg_n(*uint8 Character, uint8 Position)

Description: This function displays an 8-bit null terminated character string on an array of alphanumeric character displays. You must define what portion of the displays segments make up the alphanumeric display portion in the customizer. Multiple, separate alphanumeric displays can be created in the frame buffer and are addressed through the index (n) in the function name. Functions are only included if the component alphanumeric customizer defines the alphanumeric option.

Parameters: (uint8) Character: Pointer to the null terminated character string.

(uint8) Position: The Position of the first character as counted left to right starting at 0 on the left. If the defined display contains fewer characters then the string requires for display, the extra characters will not be displayed.

Return Value: None

Side Effects: None

void LCD_SegStat_PutChar16Seg_n(uint8 Character, uint8 Position)

Description: This function displays an 8-bit char on an array of alphanumeric character displays. You must define what portion of the displays segments make up the alphanumeric display portion in the customizer. Multiple, separate alphanumeric displays can be created in the frame buffer and are addressed through the index (n) in the function name. Functions are only included if the component alphanumeric customizer defines the alphanumeric option.

Parameters: (uint8) Character: The ASCII value of the character to display.

(uint8) Position: Position of the character as counted left to right starting at 0 on the left. If the position is outside the display range, the character will not be displayed.

Return Value: None

Side Effects: None

(void) LCD_SegStat_WriteString16Seg_n(*uint8 Character, uint8 Position)

Description: This function displays an 8-bit null terminated character string on an array of alphanumeric character displays. You must define what portion of the displays segments make up the alphanumeric display portion in the customizer. Multiple, separate alphanumeric displays can be created in the frame buffer and are addressed through the index (n) in the function name. Functions are only included if the component alphanumeric customizer defines the alphanumeric option.

Parameters: (uint8) Character: Pointer to the null terminated character string.

(uint8) Position: The Position of the first character as counted left to right starting at 0 on the left. If the defined display contains fewer characters then the string requires for display, the extra characters will not be displayed.

Return Value: None

Side Effects: None

Defines

LCD_SegStat_SEG_NUM

Defines the number of segment lines for the user-defined display current configuration of the component.

LCD_SegStat_FRAME_RATE

Defines the refresh rate for the user-defined display current configuration of the component.

LCD_SegStat_WRITE_PIXEL

This is just a macro define of the WritePixel function.

LCD_SegStat_READ_PIXEL

A macro define of the ReadPixel function.

LCD_SegStat_FIND_PIXEL

This macros calculates pixel location in the frame buffer. It uses an information from customizer pixel table and information of physical pins which will be dedicated for the LCD. This macros is the base of pixel mapping mechanism. Every pixel name from the pixel table will be defined with calculated pixel location in the frame buffer and APIs will use pixel names to access the respective pixel.

Sample Firmware Source Code

The following is a C language example demonstrating the basic functionality of the Segment LCD component. This example assumes the component has been placed in a design with the default name LCD_SegStat_1.

Note If you rename your component you must also edit the example code as appropriate to match the component name you specify.

```
#include <device.h>

void main()
{
   LCD_SegStat_1_Start();
   LCD_SegStat_1_WritePixel(SEG0,1);
   LCD_SegStat_1_ReadPixel(SEG0);
   LCD_SegStat_1_ClearDisplay();
   LCD_SegStat_1_Stop();
}
```

Functional Description

The Segment LCD component provides a powerful and flexible mechanism for driving different types of LCD glass. The Configuration dialog provides access to the parameters that can be used to customize the component. The automatic API generation provides the required API routines based on the selections made in the “Display Helpers” section of the configuration dialog.

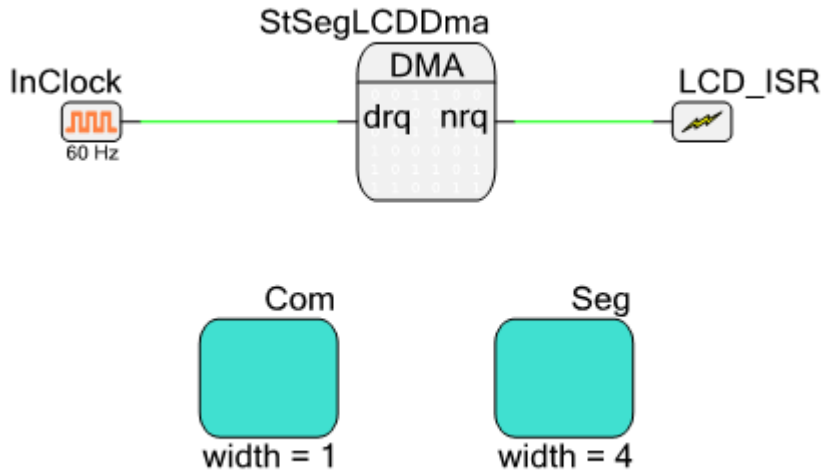
Default Configuration

The default configuration of the LCD_SegStat component provides a generic Direct LCD Segment drive controller. By default, the LCD_SegStat configuration is as follows:

- 4 Segment lines
- 30 Hz refresh rate
- No helpers are chosen. This means no APIs will be provided for a specific type of display.

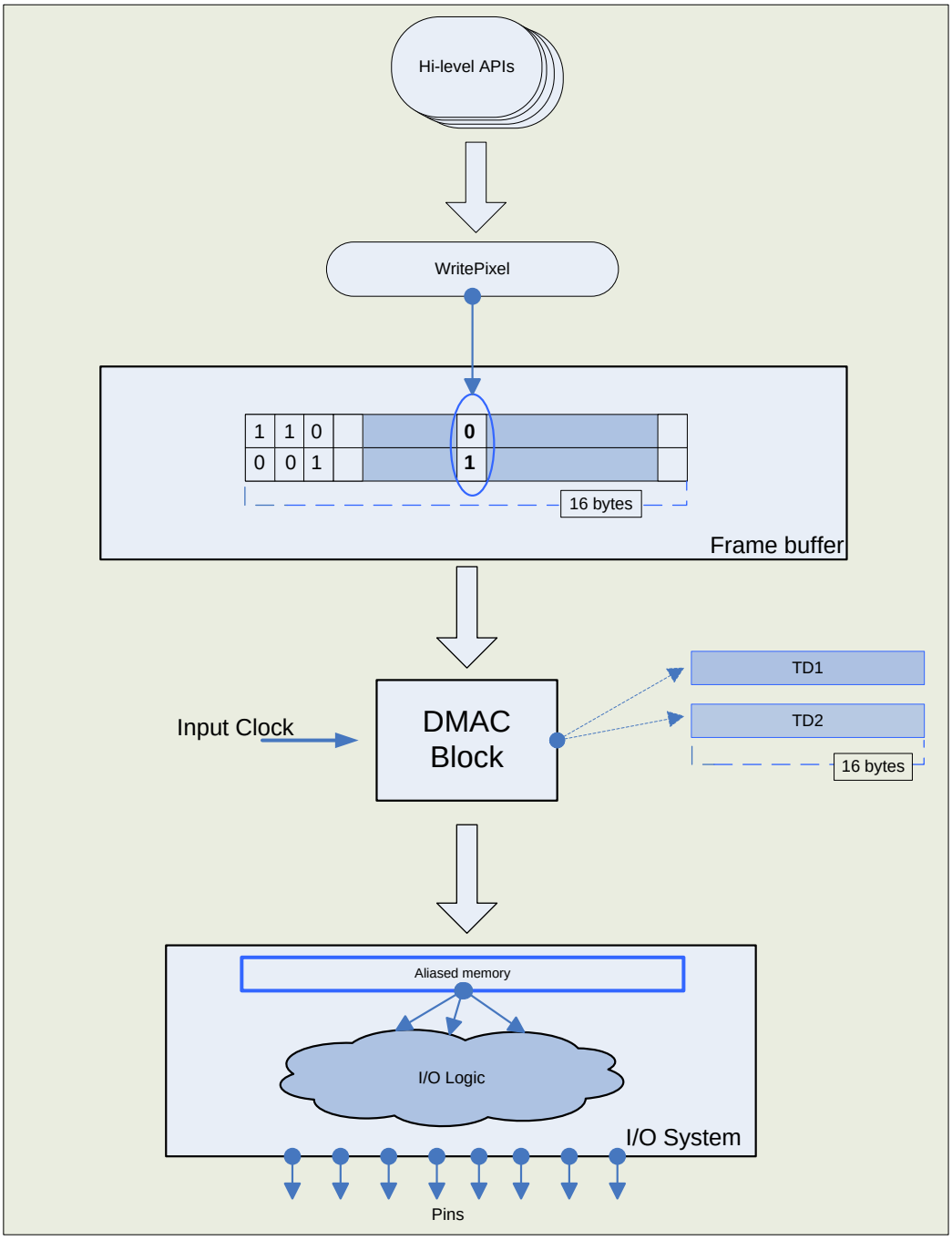
Block Diagram and Configuration

The following diagram shows the schematic representation of the Segment LCD – Static component. The component does not require special purpose LCD drive hardware. The component makes use of the DMA and standard digital port I/Os. .



The following figure shows the functional representation of the Segment LCD – Static component.

Figure 2 Top Level Architecture



Registers

None.

References

Not applicable

DC and AC Electrical Characteristics

5.0V/3.3V DC and AC Electrical Characteristics

TBD.

Component Changes

This section lists the major changes in the component from the previous version.

Version	Description of Changes	Reason for Changes / Impact
1.10.a	Moved local parameters to formal parameter list.	To address a defect that existed in PSoC Creator v1.0 Beta 4.1 and earlier, the component was updated so that it could continue to be used in newer versions of the tool. This component used local parameters, which are not exposed to the user, to do background calculations on user input. These parameters have been changed to formal parameters which are visible, but un-editable. There are no functional changes to the component but the affected parameters are now visible in the “expression view” of the customizer dialog.
1.10.b	Added information to the component that advertizes its compatibility with silicon revisions.	The tool reports an error/warning if the component is used on incompatible silicon. If this happens, update to a revision that supports your target device.