ECG-HRM

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4 Module Documentation

4.1 Device Drivers

Device driver modules.

Modules

- ADC
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- GPIO
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- ILI9341
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- PLL
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- SPI
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4.1.1 Detailed Description

Device driver modules.

4.1.2 ADC

Analog-to-digital conversion module.

Files

- file ADC.h

  Driver module for analog-to-digital conversion (ADC)

4.1.2.1 Detailed Description

Analog-to-digital conversion module.

4.1.3 GPIO

GPIO Port F module.

Files

- file GPIO.h

  Driver module for using the LaunchPad's onboard switches and RGB LEDs for GPIO and interrupts.

Functions

- void GPIO_PF_Init (void)

  Initialize GPIO Port F.
- void GPIO_PF_LED_Init (void)

  Initialize PF1-3 to interface the LaunchPad's onboard RGB LED.
- void GPIO_PF_LED_Write (uint8_t color_mask, uint8_t on_or_off)

  Write a 1 or 0 to the selected LED(s).
- void GPIO_PF_LED_Toggle (uint8_t color_mask)

  Toggle the selected LED(s).
- void GPIO_PF_Sw_Init (void)

  Initialize PF0/4 to interface the LaunchPad's onboard switches. PF4 is Sw1, and PF0 is Sw2.
- void GPIO_PF_Interrupt_Init (void)

  Initialize GPIO Port F interrupts via Sw1 and Sw2.

4.1.3.1 Detailed Description

GPIO Port F module.

4.1.3.2 Function Documentation

GPIO_PF_Init()

```
void GPIO_PF_Init (
            void  )
```

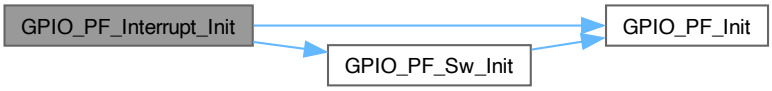
Initialize GPIO Port F.

GPIO_PF_Interrupt_Init()

```
void GPIO_PF_Interrupt_Init (
            void  )
```

Initialize GPIO Port F interrupts via Sw1 and Sw2.

Here is the call graph for this function:



GPIO_PF_LED_Init()

```
void GPIO_PF_LED_Init (
            void  )
```

Initialize PF1-3 to interface the LaunchPad's onboard RGB LED.

Here is the call graph for this function:

GPIO_PF_LED_Toggle()

```
void GPIO_PF_LED_Toggle (
            uint8_t color_mask )
```

Toggle the selected LED(s).

Parameters

color_mask	Hex. number of LED pin(s) to write to. 0x02 (PF1) – RED; 0x04 (PF2) – BLUE; 0x08 (PF3) – GREEN

GPIO_PF_LED_Write()

```
void GPIO_PF_LED_Write (
             uint8_t color_mask,
             uint8_t on_or_off )
```

Write a 1 or 0 to the selected LED(s).

Parameters

color_mask	Hex. number of LED pin(s) to write to. 0x02 (PF1) – RED; 0x04 (PF2) – BLUE; 0x08 (PF3) – GREEN
on_or_off	=0 for OFF, >=1 for ON

GPIO_PF_Sw_Init()

```
void GPIO_PF_Sw_Init (
             void  )
```

Initialize PF0/4 to interface the LaunchPad's onboard switches. PF4 is Sw1, and PF0 is Sw2.

Here is the call graph for this function:

4.1.4 ILI9341

Module for interfacing ILI9341-based RGB LCD via SPI .

Files

- file ILI9341.h

  Driver module for interfacing with an ILI9341 LCD driver.

Macros

- #define **NOP** (uint8_t) 0x00
- #define **SWRESET** (uint8_t) 0x01
- #define **RDDST** (uint8_t) 0x09
- #define **RDDMADCTL** (uint8_t) 0x0B
- #define **RDDCOLMOD** (uint8_t) 0x0C
- #define **DINVOFF** (uint8_t) 0x20
- #define **DINVON** (uint8_t) 0x21
- #define **CASET** (uint8_t) 0x2A
- #define **PASET** (uint8_t) 0x2B
- #define **RAMWR** (uint8_t) 0x2C
- #define **RAMRD** (uint8_t) 0x2E
- #define **DISPOFF** (uint8_t) 0x28
- #define **DISPON** (uint8_t) 0x29
- #define **VSCRDEF** (uint8_t) 0x33
- #define **MADCTL** (uint8_t) 0x36
- #define **VSCRSADD** (uint8_t) 0x37
- #define **PIXSET** (uint8_t) 0x3A
- #define **WRDISBV** (uint8_t) 0x51
- #define **RDDISBV** (uint8_t) 0x52
- #define **IFMODE** (uint8_t) 0xB0
- #define **FRMCTR1** (uint8_t) 0xB1
- #define **PRCTR** (uint8_t) 0xB5
- #define **IFCTL** (uint8_t) 0xF6
- #define **NUM_COLS** (uint8_t) 240
- #define **NUM_ROWS** (uint8_t) 320

Functions

- void ILI9341_Init (void)

  Initialize the LCD driver.
- void ILI9341_ResetHard (void)

  Perform a hardware reset of the LCD driver.
- void ILI9341_ResetSoft (void)

  Perform a software reset of the LCD driver.
- void **ILI9341_NoOpCmd** (void)

  Send the "No Operation" command (NOP) to the LCD driver. Can be used to terminate the "Memory Write" and "Memory Read" commands (RAMWR and RAMRD, respectively), but does nothing otherwise.
- uint8_t * **ILI9341_getDispStatus** (void)
- uint8_t **ILI9341_getMemAccessCtrl** (void)
- void ILI9341_setRowAddress (uint16_t start_row, uint16_t end_row)

  Sets the start/end rows to be written to.
- void ILI9341_setColAddress (uint16_t start_col, uint16_t end_col)

  Sets the start/end rows to be written to.
- void **ILI9341_writeMemCmd** (void)

  Sends the "Write Memory" command (RAMWR). Should be used before ILI9341_write1px().
- void ILI9341_write1px (uint8_t data[3])

  Write a single pixel to memory. Should be used after ILI9341_writeMemCmd().
- void ILI9341_setDispInversion (uint8_t is_ON)

  Send command to toggle display display inversion.
- void ILI9341_setDisplayStatus (uint8_t is_ON)

Send command to turn the display ON or OFF.

- void **ILI9341_setVertScrollArea** (uint16_t top_fixed, uint16_t vert_scroll, uint16_t bottom_fixed)
- void **ILI9341_setVertScrollStart** (uint16_t start_address)
- void **ILI9341_setMemAccessCtrl** (uint8_t row_address_order, uint8_t col_address_order, uint8_t row_col↩ _exchange, uint8_t vert_refresh_order, uint8_t rgb_order, uint8_t hor_refresh_order)
- void **ILI9341_setPixelFormat** (uint8_t is_16bit)
- void ILI9341_setDispBrightness (uint8_t brightness)

  Sets the brightness value of the display.
- uint8_t **ILI9341_getDispBrightness** (void)
- void ILI9341_setDispInterface (uint8_t param)

  Send command to set operation status of display interface.
- void **ILI9341_setFrameRate** (uint8_t div_ratio, uint8_t clocks_per_line)
- void **ILI9341_setBlankingPorch** (uint8_t vert_front_porch, uint8_t vert_back_porch, uint8_t hor_front_porch, uint8_t hor_back_porch)
- void ILI9341_setInterface (void)

  Sets the interface for the ILI9341.

4.1.4.1 Detailed Description

Module for interfacing ILI9341-based RGB LCD via SPI .

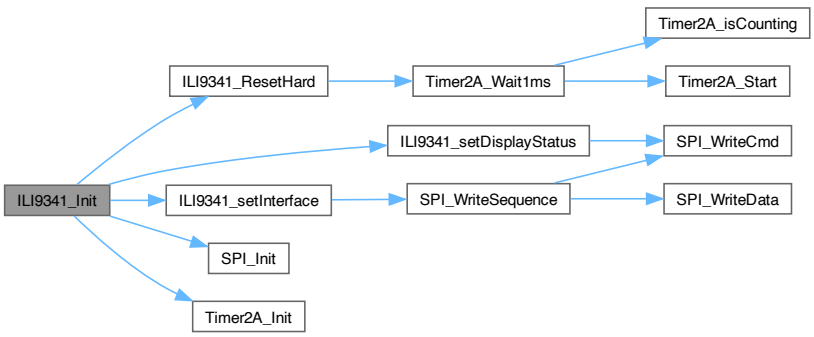
4.1.4.2 Function Documentation

ILI9341_Init()

```
void ILI9341_Init (
            void  )
```

Initialize the LCD driver.

This function initializes the SPI (i.e. SSI0) and Timer2A peripherals, initiates a hardware reset of the display, and tunes the display interface to allow blanking porch values to be manipulated via SPI commands.Here is the call graph for this function:

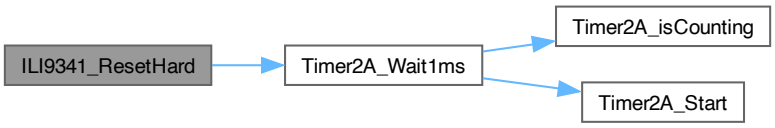


ILI9341_ResetHard()

```
void ILI9341_ResetHard (
            void  )
```

Perform a hardware reset of the LCD driver.

The ILI9341's RESET signal requires a negative logic (i.e. active LOW) signal for >= 10 [us] and an additional 5 [ms] before further commands can be sent.
Here is the call graph for this function:

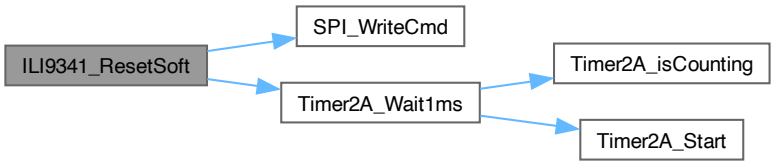


ILI9341_ResetSoft()

```
void ILI9341_ResetSoft (
            void  )
```

Perform a software reset of the LCD driver.

The ILI9341 requires an additional 5 [ms] before further commands can be sent after a reset.
Here is the call graph for this function:



ILI9341_setColAddress()

```
void ILI9341_setColAddress (
            uint16_t start_col,
            uint16_t end_col )
```

Sets the start/end rows to be written to.

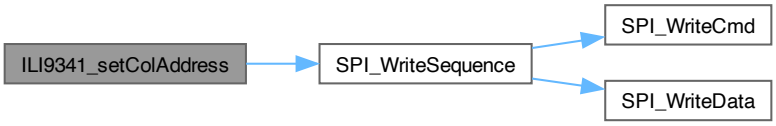
Parameters

start_col	0 <= `start_col` <= `end_col`
end_col	`start_col` <= `end_col` < 240

This function implements the ¨Column Address Set¨ command from p. 110 of the ILI9341 datasheet.

The input parameters represent the first and last columns to be written to when ILI9341_WriteMem() is called.

To work correctly, `start_col` must be no greater than `end_col`, and `end_col` cannot be greater than 239.Here is the call graph for this function:



ILI9341_setDispBrightness()

```
void ILI9341_setDispBrightness (
             uint8_t brightness )
```

Sets the brightness value of the display.

Parameters

brightness	value between `0` (lowest) and `255` (highest)

Here is the call graph for this function:

ILI9341_setDispInterface()

```
void ILI9341_setDispInterface (
```

```
            uint8_t param )
```

Send command to set operation status of display interface.

Parameters

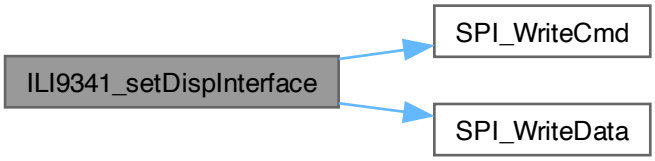
param	

This function sets the display interface according to the following table, adapted from pg. 154 of the ILI9341 datasheet.

Bit	7	6	5	4	3	2	1	0
Value	ByPass_MODE	RCM[1]	RCM[0]	0	VSPL	HSPL	DPL	EPL
Default	0	1	0	0	0	0	0	1

Name	Description	0	1	Notes
ByPass_MODE	display data path	shift register	memory	N/A
RCM[1]	RGB interface select	N/A	N/A	Always `1`
RCM[0]	RGB interface select	`DE`	`SYNC`	use `SYNC` to set blanking porch w/o `DE` bit/signal
VPSL	VSYNC polarity	low level	high level	N/A
HSPL	HSYNC polarity	low level	high level	N/A
DPL	DOTCLK polarity	rising edge	falling edge	when to fetch data relative to the dot clock
EPL	DE polarity	high enable	low enable	irrelevant in `SYNC` mode

Here is the call graph for this function:



ILI9341_setDispInversion()

```
void ILI9341_setDispInversion (
            uint8_t is_ON )
```

Send command to toggle display display inversion.

Parameters

is_ON	1 to turn ON, 0 to turn OFF

Here is the call graph for this function:

ILI9341_setDisplayStatus()

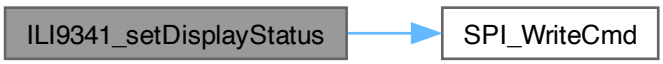
```
void ILI9341_setDisplayStatus (
            uint8_t is_ON )
```

Send command to turn the display ON or OFF.

Parameters

is_ON	1 to turn ON, 0 to turn OFF

Here is the call graph for this function:

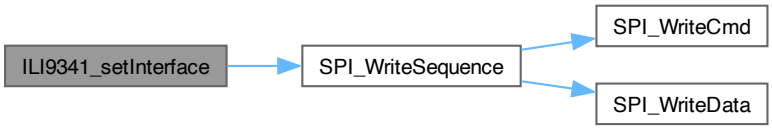


ILI9341_setInterface()

```
void ILI9341_setInterface (
            void  )
```

Sets the interface for the ILI9341.

RGB Interface, 6-bit data transfer (3 transfer/pixel)Here is the call graph for this function:



ILI9341_setRowAddress()

```
void ILI9341_setRowAddress (
            uint16_t start_row,
            uint16_t end_row )
```

Sets the start/end rows to be written to.

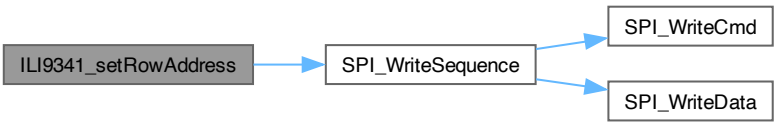
Parameters

start_row	0 <= `start_row` <= `end_row`
end_row	`start_row` <= `end_row` < 320

This function implements the ¨Page Address Set¨ command from p. 112 of the ILI9341 datasheet.

The input parameters represent the first and last rows to be written to when ILI9341_WriteMem() is called.

To work correctly, `start_row` must be no greater than `end_row`, and `end_row` cannot be greater than 319.Here is the call graph for this function:



ILI9341_write1px()

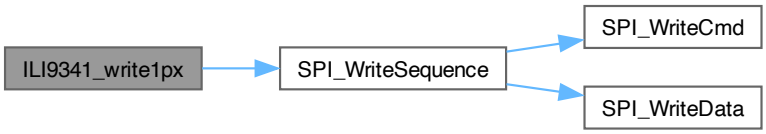
```
void ILI9341_write1px (
            uint8_t data[3] )
```

Write a single pixel to memory. Should be used after `ILI9341_writeMemCmd()`.

Parameters

data	

Here is the call graph for this function:



4.1.5 PLL

Phase-locked loop module.

Functions

- void PLL_Init (void)

  Initializes the phase-locked-loop (PLL), allowing a bus frequency of 80[MHz].

4.1.5.1 Detailed Description

Phase-locked loop module.

4.1.5.2 Function Documentation

PLL_Init()

```
void PLL_Init (
             void  )
```

Initializes the phase-locked-loop (PLL), allowing a bus frequency of 80[MHz].

4.1.6 SPI

Serial peripheral interface module.

Functions

- void SPI_Init (void)

  Initialize SSI0 to act as an SPI Controller (AKA Master) in mode 0.
- uint8_t SPI_Read (void)

  Read data from peripheral.
- void SPI_WriteCmd (uint8_t cmd)

  Write an 8-bit command to the peripheral.
- void SPI_WriteData (uint8_t data)

  Write 8-bit data to the peripheral.
- void SPI_WriteSequence (uint8_t cmd, uint8_t param_sequence[ ], uint8_t num_params)

  Write a sequence of data to the peripheral, with or without a preceding command.

4.1.6.1 Detailed Description

Serial peripheral interface module.

4.1.6.2 Function Documentation

SPI_Init()

```
void SPI_Init (
            void  )
```

Initialize SSI0 to act as an SPI Controller (AKA Master) in mode 0.

TM4C Pin	Function	ILI9341 Pin	Description
PA2	SSI0Clk	CLK	Serial clock signal
PA3	SSI0Fss	CS	Chip select signal
PA4	SSI0Rx	MISO	TM4C (M) input, LCD (S) output
PA5	SSI0Tx	MOSI	TM4C (M) output, LCD (S) input
PA6	GPIO	D/C	Data = 1, Command = 0
PA7	GPIO	RESET	Reset the display (negative logic/active `LOW`)

Clk. Polarity = steady state low (0)
Clk. Phase = rising clock edge (0)
The bit rate `BR` is set using the clock prescale divisor `CPSDVSR` and `SCR` field in the SSI Control 0 (`CR0`) register:

$\fBR = f_{bus} / (CPSDVSR ∗ (1 + SCR))$\f

The ILI9341 driver has a minimum write cycle of 100 [ns], corresponding to a maximum serial clock frequency of 10 [MHz]. Thus, this function sets the bit rate `BR` to be the bus frequency ($\ff_{bus} = 80 [MHz]$\f) divided by 10 ($\f8 [MHz]).

SPI_Read()

```
uint8_t SPI_Read (
            void  )
```

Read data from peripheral.

Returns

uint8_t

SPI_WriteCmd()

```
void SPI_WriteCmd (
             uint8_t cmd )
```

Write an 8-bit command to the peripheral.

Parameters

cmd	command for peripheral

SPI_WriteData()

```
void SPI_WriteData (
             uint8_t data )
```

Write 8-bit data to the peripheral.

Parameters

data	input data for peripheral

SPI_WriteSequence()

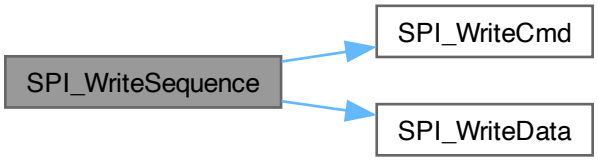
```
void SPI_WriteSequence (
             uint8_t cmd,
             uint8_t param_sequence[],
             uint8_t num_params )
```

Write a sequence of data to the peripheral, with or without a preceding command.

Parameters

cmd	8-bit command (using `cmd = 0` omits the command)
param_sequence	sequence of parameters to send after `cmd`
num_params	number of parameters to send; should be <= size of `param_sequence`

Here is the call graph for this function:



4.1.7 SysTick

SysTick timing module.

Functions

- void SysTick_Timer_Init (void)
  Initialize SysTick for timing purposes.
- void **SysTick_Wait1ms** (uint32_t delay_ms)
  Delay for specified amount of time in [ms]. Assumes f_bus = 80[MHz].
- void SysTick_Interrupt_Init (uint32_t time_ms)
  Initialize SysTick for interrupts.

4.1.7.1 Detailed Description

SysTick timing module.

4.1.7.2 Function Documentation

SysTick_Interrupt_Init()

```
void SysTick_Interrupt_Init (
            uint32_t time_ms )
```

Initialize SysTick for interrupts.

Parameters

time_ms	Time in [ms] between interrupts. Cannot be more than 200[ms].

SysTick_Timer_Init()

```
void SysTick_Timer_Init (
            void  )
```

Initialize SysTick for timing purposes.

4.1.8 Timer

Timer0A module.

Files

- file Timer.c

  Implementation for timer module.
- file Timer.h

  Driver module for timing (Timer0) and interrupts (Timer1).

Functions

- void Timer0A_Init (void)

  Initialize timer 0 as 32-bit, one-shot, countdown timer.
- void Timer0A_Start (uint32_t time_ms)

  Count down starting from the inputted value.
- uint8_t Timer0A_isCounting (void)

  Returns 1 if Timer0 is still counting and 0 if not.
- void Timer0A_Wait1ms (uint32_t time_ms)

  Wait for the specified amount of time in [ms].
- void Timer2A_Init (void)

  Initialize timer 2 as 32-bit, one-shot, countdown timer.
- void Timer2A_Start (uint32_t time_ms)

  Count down starting from the inputted value.
- uint8_t Timer2A_isCounting (void)

  Returns 1 if Timer2 is still counting and 0 if not.
- void Timer2A_Wait1ms (uint32_t time_ms)

  Wait for the specified amount of time in [ms].

4.1.8.1 Detailed Description

Timer0A module.

4.1.8.2 Function Documentation

Timer0A_Init()

```
void Timer0A_Init (
            void  )
```

Initialize timer 0 as 32-bit, one-shot, countdown timer.

Timer0A_isCounting()

```
uint8_t Timer0A_isCounting (
            void  )
```

Returns 1 if Timer0 is still counting and 0 if not.

Returns

uint8_t status

Timer0A_Start()

```
void Timer0A_Start (
            uint32_t time_ms )
```

Count down starting from the inputted value.

Parameters

time_ms	Time in [ms] to load into Timer 0. Must be <= 53 seconds.

Timer0A_Wait1ms()

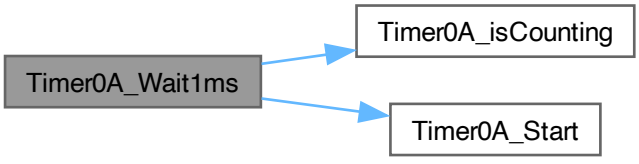
```
void Timer0A_Wait1ms (
            uint32_t time_ms )
```

Wait for the specified amount of time in [ms].

Parameters

time_ms	Time in [ms] to load into Timer 0. Must be <= 53 seconds.

Here is the call graph for this function:



Timer2A_Init()

```
void Timer2A_Init (
            void  )
```

Initialize timer 2 as 32-bit, one-shot, countdown timer.

Timer2A_isCounting()

```
uint8_t Timer2A_isCounting (
            void  )
```

Returns 1 if Timer2 is still counting and 0 if not.

Returns

uint8_t status

Timer2A_Start()

```
void Timer2A_Start (
            uint32_t time_ms )
```

Count down starting from the inputted value.

Parameters

time_ms	Time in [ms] to load into Timer 2. Must be <= 53 seconds.

Timer2A_Wait1ms()

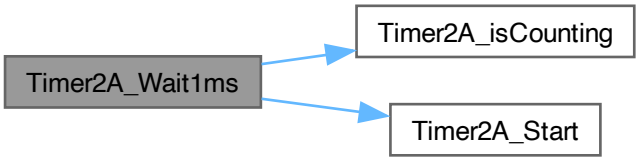
```
void Timer2A_Wait1ms (
            uint32_t time_ms )
```

Wait for the specified amount of time in [ms].

Parameters

time_ms	Time in [ms] to load into Timer 2. Must be <= 53 seconds.

Here is the call graph for this function:



4.1.9 UART

UART0 module.

Functions

- void UART0_Init (void)

  Initialize UART0 to a baud rate of 115200, 8-bit data length, 1 start bit, and 1 stop bit.
- unsigned char UART0_ReadChar (void)

  Read a single character from UART0.
- void UART0_WriteChar (unsigned char input_char)

  Write a single character to UART0.
- void UART0_WriteStr (unsigned char ∗str_ptr)

  Write a C string to UART0.
- void UART1_Init (void)

  Initialize UART1 to a baud rate of 115200, 8-bit data length, 1 start bit, and 1 stop bit.
- unsigned char UART1_ReadChar (void)

  Read a single character from UART1.
- void UART1_WriteChar (unsigned char input_char)

  Write a single character to UART1.
- void UART1_WriteStr (unsigned char ∗str_ptr)

  Write a C string to UART1.

4.1.9.1 Detailed Description

UART0 module.

4.1.9.2 Function Documentation

UART0_Init()

```
void UART0_Init (
            void  )
```

Initialize UART0 to a baud rate of 115200, 8-bit data length, 1 start bit, and 1 stop bit.

Given the bus frequency (`f_bus`) and desired baud rate (`BR`), the baud rate divisor (`BRD`) can be calculated: $BRD = f_{bus}/(16 * BR)$

The integer BRD (`IBRD`) is simply the integer part of the BRD: $IBRD = int(BRD)$

The fractional BRD (`FBRD`) is calculated using the fractional part (`mod(BRD,1)`) of the BRD: $FBRD = int((mod(BRD, 1) * 64) + 0.5)$

NOTE: LCRH must be accessed *AFTER* setting the `BRD` register0

UART0_ReadChar()

```
unsigned char UART0_ReadChar (
            void  )
```

Read a single character from UART0.

Returns

input_char

This function uses busy-wait synchronization to read a character from UART0.

UART0_WriteChar()

```
void UART0_WriteChar (
            unsigned char input_char )
```

Write a single character to UART0.

Parameters

input_char	

This function uses busy-wait synchronization to write a character to UART0.

UART0_WriteStr()

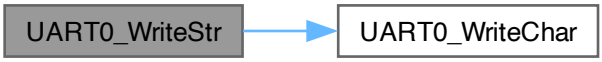
```
void UART0_WriteStr (
            unsigned char * str_ptr )
```

Write a C string to UART0.

Parameters

str_ptr	pointer to C string

This function uses UART0_WriteChar() function to write a C string to UART0. The function writes until either the entire string has been written or a null-terminated character has been reached.Here is the call graph for this function:



UART1_Init()

```
void UART1_Init (
            void  )
```

Initialize UART1 to a baud rate of 115200, 8-bit data length, 1 start bit, and 1 stop bit.

Given the bus frequency (`f_bus`) and desired baud rate (`BR`), the baud rate divisor (`BRD`) can be calculated: $BRD = f_{bus}/(16 * BR)$

The integer BRD (`IBRD`) is simply the integer part of the BRD: $IBRD = int(BRD)$

The fractional BRD (`FBRD`) is calculated using the fractional part (`mod(BRD,1)`) of the BRD: $FBRD = int((mod(BRD, 1) * 64) + 0.5)$

NOTE: LCRH must be accessed *AFTER* setting the `BRD` register

UART1_ReadChar()

```
unsigned char UART1_ReadChar (
            void  )
```

Read a single character from UART1.

Returns

input_char

This function uses busy-wait synchronization to read a character from UART1.

UART1_WriteChar()

```
void UART1_WriteChar (
            unsigned char input_char )
```

Write a single character to UART1.

Parameters

input_char	

This function uses busy-wait synchronization to write a character to UART1.

UART1_WriteStr()

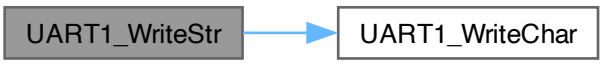
```
void UART1_WriteStr (
            unsigned char * str_ptr )
```

Write a C string to UART1.

Parameters

str_ptr	pointer to C string

This function uses UART1_WriteChar() function to write a C string to UART0. The function writes until either the entire string has been written or a null-terminated character has been reached.Here is the call graph for this function:



4.2 Application Software

Application-specific modules.

Application-specific modules.

4.3 Program Threads

Program Threads.

Functions

- void GPIO_PortF_Handler ()

  ISR for facilitating user control of program state.
- void SysTick_Handler ()

  ISR for collecting ECG samples @ f_s = 200 [Hz].
- void Timer1A_Handler ()

  ISR for updating the LCD @ f_s = 30 [Hz].
- void Timer1A_Init (uint32_t time_ms)

  Initialize timer 1 as a 32-bit, periodic, countdown timer with interrupts.
- int **main** (void)

4.3.1 Detailed Description

Program Threads.

4.3.2 Function Documentation

GPIO_PortF_Handler()

```
void GPIO_PortF_Handler ( )
```

ISR for facilitating user control of program state.

SysTick_Handler()

```
void SysTick_Handler ( )
```

ISR for collecting ECG samples @ f_s = 200 [Hz].

Timer1A_Handler()

```
void Timer1A_Handler ( )
```

ISR for updating the LCD @ f_s = 30 [Hz].

Timer1A_Init()

```
void Timer1A_Init (
            uint32_t time_ms )
```

Initialize timer 1 as a 32-bit, periodic, countdown timer with interrupts.

Parameters

time_ms	Time in [ms] between interrupts. Must be <= 53 seconds.

5 Data Structure Documentation

5.1 FIFO_buffer_t Struct Reference

Array-based FIFO buffer type.

Data Fields

- volatile uint16_t * **front_ptr**
- volatile uint16_t * **rear_ptr**
- volatile uint32_t **curr_size**
- uint32_t **MAX_SIZE**

5.1.1 Detailed Description

Array-based FIFO buffer type.

Parameters

front_ptr	pointer to the first element of the buffer.
rear_ptr	pointer to the last element of the buffer.
curr_size	current number of elements within the buffer.
MAX_SIZE	maximum number of elements allowed within buffer.

The documentation for this struct was generated from the following file:

- fifo_buff.c

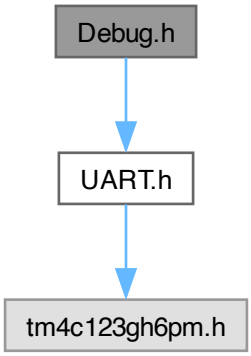
6 File Documentation

6.1 Debug.h File Reference

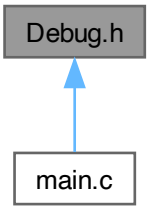
Functions to output debugging information to a serial port via UART.

```
#include ¨UART.h¨
```

Include dependency graph for Debug.h:



This graph shows which files directly or indirectly include this file:



6.1.1 Detailed Description

Functions to output debugging information to a serial port via UART.

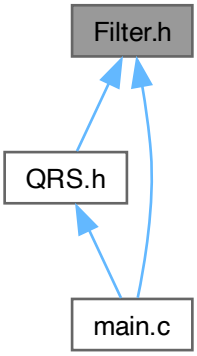
Author

Bryan McElvy

6.2 Filter.h File Reference

Functions to implement digital filters via linear constant coefficient difference equations (LCCDEs).

This graph shows which files directly or indirectly include this file:



6.2.1 Detailed Description

Functions to implement digital filters via linear constant coefficient difference equations (LCCDEs).

Author

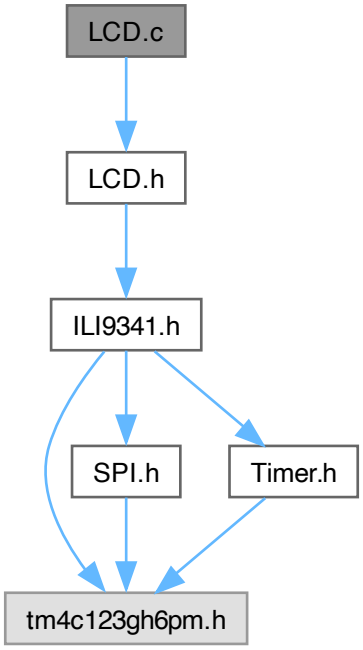
Bryan McElvy

6.3 LCD.c File Reference

Source code for LCD module.

```
#include ¨LCD.h¨
```

Include dependency graph for LCD.c:



Functions

- void LCD_Init (void)

  Initializes and configures the ILI9341 LCD driver.

6.3.1 Detailed Description

Source code for LCD module.

Author

Bryan McElvy

6.3.2 Function Documentation

LCD_Init()

```
void LCD_Init (
            void  )
```

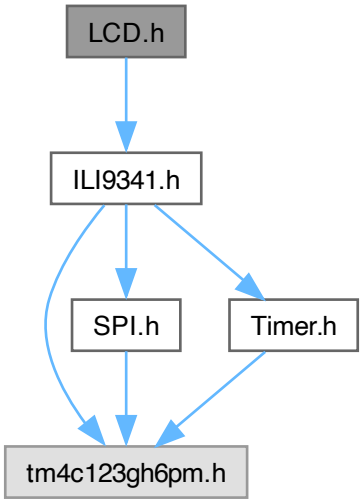
Initializes and configures the ILI9341 LCD driver.

6.4 LCD.h File Reference

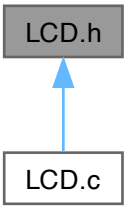
Module for outputting the ECG waveform and HR to a liquid crystal display (LCD).

```
#include ¨ILI9341.h¨
```

Include dependency graph for LCD.h:



This graph shows which files directly or indirectly include this file:



Functions

- void LCD_Init (void)

  Initializes and configures the ILI9341 LCD driver.

6.4.1 Detailed Description

Module for outputting the ECG waveform and HR to a liquid crystal display (LCD).

Author

Bryan McElvy

6.4.2 Function Documentation

LCD_Init()

```
void LCD_Init (
            void  )
```

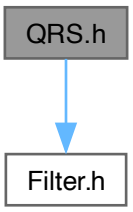
Initializes and configures the ILI9341 LCD driver.

6.5 QRS.h File Reference

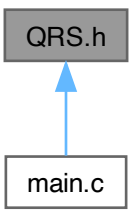
QRS detection algorithm functions.

```
#include ¨Filter.h¨
```

Include dependency graph for QRS.h:



This graph shows which files directly or indirectly include this file:



6.5.1 Detailed Description

QRS detection algorithm functions.

Author

Bryan McElvy

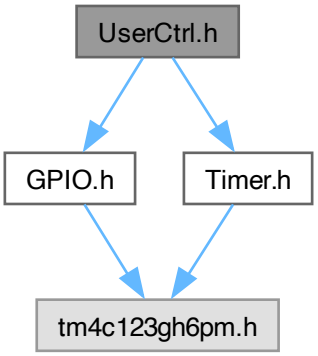
This module contains functions for detecting heart rate (HR) using a simplified version of the Pan-Tompkins algorithm.

6.6 UserCtrl.h File Reference

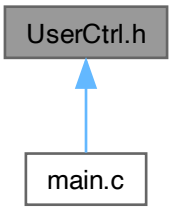
Interface for user control module.

```
#include ¨GPIO.h¨
#include ¨Timer.h¨
```

Include dependency graph for UserCtrl.h:



This graph shows which files directly or indirectly include this file:



Functions

- void UserCtrl_Init ()

  Initializes the UserCtrl module and its dependencies (Timer0B and GPIO_PortF)

6.6.1 Detailed Description

Interface for user control module.

Author

Bryan McElvy

6.6.2 Function Documentation

UserCtrl_Init()

```
void UserCtrl_Init ( )
```

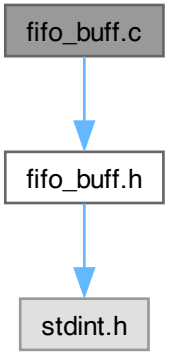
Initializes the UserCtrl module and its dependencies (Timer0B and GPIO_PortF)

6.7 fifo_buff.c File Reference

Source code file for FIFO buffer type.

```
#include ¨fifo_buff.h¨
```

Include dependency graph for fifo_buff.c:



Data Structures

- struct FIFO_buffer_t

  Array-based FIFO buffer type.

Functions

- FIFO_buffer_t FIFO_init (uint32_t buffer_size)

  Initializes a FIFO buffer with the specified size.
- void FIFO_add_sample (FIFO_buffer_t *FIFO_ptr, uint16_t sample)

  Adds a 16-bit sample to the end of the FIFO buffer at the specified address.
- uint16_t FIFO_rem_sample (FIFO_buffer_t *FIFO_ptr)

  Removes the first element of the FIFO buffer at the specified address.
- uint32_t FIFO_get_size (FIFO_buffer_t *FIFO_ptr)

  Gets the size of the FIFO buffer at the specified address.
- void FIFO_show_data (FIFO_buffer_t *FIFO_ptr)

  Shows all of the items in the FIFO buffer at the specified address. NOTE: Intended for debugging purposes only.

6.7.1 Detailed Description

Source code file for FIFO buffer type.

Author

Bryan McElvy

6.7.2 Function Documentation

FIFO_add_sample()

```
void FIFO_add_sample (
             FIFO_buffer_t * FIFO_ptr,
             uint16_t sample )
```

Adds a 16-bit sample to the end of the FIFO buffer at the specified address.

Parameters

FIFO_buffer	pointer to FIFO buffer
sample	data sample to be added

Returns

None

FIFO_get_size()

```
uint32_t FIFO_get_size (
             FIFO_buffer_t * FIFO_ptr )
```

Gets the size of the FIFO buffer at the specified address.

Parameters

FIFO_ptr	pointer to FIFO buffer

Returns

curr_size

FIFO_init()

```
FIFO_buffer_t FIFO_init (
            uint32_t buffer_size )
```

Initializes a FIFO buffer with the specified size.

Parameters

buffer_size	desired buffer size.

Returns

FIFO_buffer

FIFO_rem_sample()

```
uint16_t FIFO_rem_sample (
            FIFO_buffer_t * FIFO_ptr )
```

Removes the first element of the FIFO buffer at the specified address.

Parameters

FIFO_ptr	pointer to FIFO buffer

Returns

uint16_t

FIFO_show_data()

```
void FIFO_show_data (
            FIFO_buffer_t * FIFO_ptr )
```

Shows all of the items in the FIFO buffer at the specified address. NOTE: Intended for debugging purposes only.

Parameters

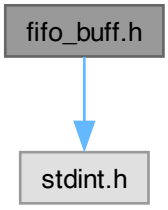
FIFO_ptr	pointer to FIFO buffer

6.8 fifo_buff.h File Reference

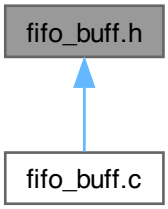
Header file for FIFO buffer type.

```
#include <stdint.h>
```

Include dependency graph for fifo_buff.h:



This graph shows which files directly or indirectly include this file:



Functions

- FIFO_buffer_t FIFO_init (uint32_t buffer_size)

  Initializes a FIFO buffer with the specified size.
- void FIFO_add_sample (FIFO_buffer_t *FIFO_ptr, uint16_t sample)

  Adds a 16-bit sample to the end of the FIFO buffer at the specified address.
- uint16_t FIFO_rem_sample (FIFO_buffer_t *FIFO_ptr)

  Removes the first element of the FIFO buffer at the specified address.
- uint32_t FIFO_get_size (FIFO_buffer_t *FIFO_ptr)

  Gets the size of the FIFO buffer at the specified address.
- void FIFO_show_data (FIFO_buffer_t *FIFO_ptr)

  Shows all of the items in the FIFO buffer at the specified address. NOTE: Intended for debugging purposes only.

6.8.1 Detailed Description

Header file for FIFO buffer type.

Author

Bryan McElvy

6.8.2 Function Documentation

FIFO_add_sample()

```
void FIFO_add_sample (
            FIFO_buffer_t * FIFO_ptr,
            uint16_t sample )
```

Adds a 16-bit sample to the end of the FIFO buffer at the specified address.

Parameters

FIFO_buffer	pointer to FIFO buffer
sample	data sample to be added

Returns

None

FIFO_get_size()

```
uint32_t FIFO_get_size (
            FIFO_buffer_t * FIFO_ptr )
```

Gets the size of the FIFO buffer at the specified address.

Parameters

FIFO_ptr	pointer to FIFO buffer

Returns

curr_size

FIFO_init()

```
FIFO_buffer_t FIFO_init (
            uint32_t buffer_size )
```

Initializes a FIFO buffer with the specified size.

Parameters

buffer_size	desired buffer size.

Returns

FIFO_buffer

FIFO_rem_sample()

```
uint16_t FIFO_rem_sample (
            FIFO_buffer_t * FIFO_ptr )
```

Removes the first element of the FIFO buffer at the specified address.

Parameters

FIFO_ptr	pointer to FIFO buffer

Returns

uint16_t

FIFO_show_data()

```
void FIFO_show_data (
            FIFO_buffer_t * FIFO_ptr )
```

Shows all of the items in the FIFO buffer at the specified address. NOTE: Intended for debugging purposes only.

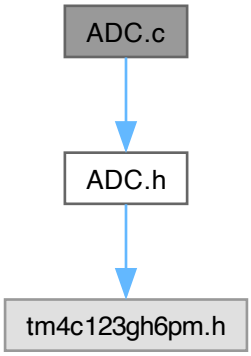
Parameters

FIFO_ptr	pointer to FIFO buffer

6.9 ADC.c File Reference

```
#include ¨ADC.h¨
```

Include dependency graph for ADC.c:



6.9.1 Detailed Description

Author

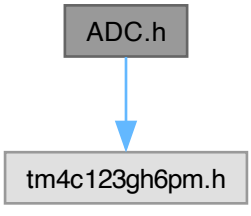
Bryan McElvy

6.10 ADC.h File Reference

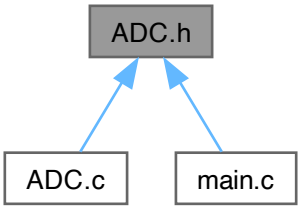
Driver module for analog-to-digital conversion (ADC)

```
#include ¨tm4c123gh6pm.h¨
```

Include dependency graph for ADC.h:



This graph shows which files directly or indirectly include this file:



6.10.1 Detailed Description

Driver module for analog-to-digital conversion (ADC)

Author

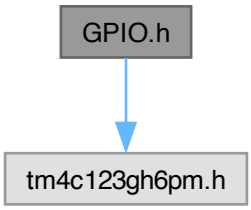
Bryan McElvy

6.11 GPIO.h File Reference

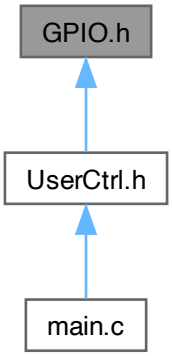
Driver module for using the LaunchPad's onboard switches and RGB LEDs for GPIO and interrupts.

```
#include ¨tm4c123gh6pm.h¨
```

Include dependency graph for GPIO.h:



This graph shows which files directly or indirectly include this file:



Functions

- void GPIO_PF_Init (void)

  Initialize GPIO Port F.
- void GPIO_PF_LED_Init (void)

  Initialize PF1-3 to interface the LaunchPad's onboard RGB LED.
- void GPIO_PF_LED_Write (uint8_t color_mask, uint8_t on_or_off)

  Write a 1 or 0 to the selected LED(s).
- void GPIO_PF_LED_Toggle (uint8_t color_mask)

  Toggle the selected LED(s).
- void GPIO_PF_Sw_Init (void)

  Initialize PF0/4 to interface the LaunchPad's onboard switches. PF4 is Sw1, and PF0 is Sw2.
- void GPIO_PF_Interrupt_Init (void)

  Initialize GPIO Port F interrupts via Sw1 and Sw2.

6.11.1 Detailed Description

Driver module for using the LaunchPad's onboard switches and RGB LEDs for GPIO and interrupts.

Author

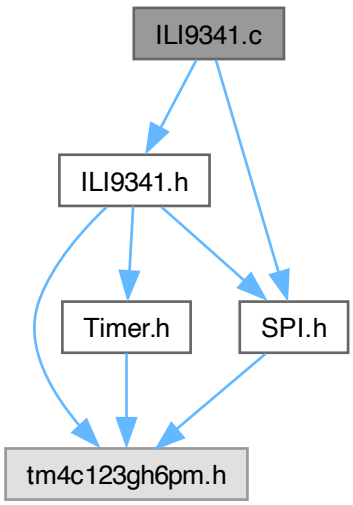
Bryan McElvy

6.12 ILI9341.c File Reference

Source code for ILI9341 module.

```
#include ¨ILI9341.h¨
#include ¨SPI.h¨
```

Include dependency graph for ILI9341.c:



Functions

- void ILI9341_Init (void)

  Initialize the LCD driver.
- void ILI9341_ResetHard (void)

  Perform a hardware reset of the LCD driver.
- void ILI9341_ResetSoft (void)

  Perform a software reset of the LCD driver.
- void **ILI9341_NoOpCmd** (void)

  Send the ¨No Operation¨ command (NOP) to the LCD driver. Can be used to terminate the ¨Memory Write¨ and ¨Memory Read¨ commands (RAMWR and RAMRD, respectively), but does nothing otherwise.
- uint8_t * **ILI9341_getDispStatus** (void)
- uint8_t **ILI9341_getMemAccessCtrl** (void)
- void ILI9341_setRowAddress (uint16_t start_row, uint16_t end_row)

  Sets the start/end rows to be written to.
- void ILI9341_setColAddress (uint16_t start_col, uint16_t end_col)

  Sets the start/end rows to be written to.
- void **ILI9341_writeMemCmd** (void)

  Sends the ¨Write Memory¨ command (RAMWR). Should be used before ILI9341_write1px().
- void ILI9341_write1px (uint8_t data[3])

  Write a single pixel to memory. Should be used after ILI9341_writeMemCmd().
- void ILI9341_setDispInversion (uint8_t is_ON)

Send command to toggle display display inversion.

- void ILI9341_setDisplayStatus (uint8_t is_ON)

  Send command to turn the display ON or OFF.
- void **ILI9341_setVertScrollArea** (uint16_t top_fixed, uint16_t vert_scroll, uint16_t bottom_fixed)
- void **ILI9341_setVertScrollStart** (uint16_t start_address)
- void **ILI9341_setMemAccessCtrl** (uint8_t row_address_order, uint8_t col_address_order, uint8_t row_col↩ _exchange, uint8_t vert_refresh_order, uint8_t rgb_order, uint8_t hor_refresh_order)
- void **ILI9341_setPixelFormat** (uint8_t is_16bit)
- void ILI9341_setDispBrightness (uint8_t brightness)

  Sets the brightness value of the display.
- uint8_t **ILI9341_getDispBrightness** (void)
- void ILI9341_setDispInterface (uint8_t param)

  Send command to set operation status of display interface.
- void **ILI9341_setFrameRate** (uint8_t div_ratio, uint8_t clocks_per_line)
- void **ILI9341_setBlankingPorch** (uint8_t vert_front_porch, uint8_t vert_back_porch, uint8_t hor_front_porch, uint8_t hor_back_porch)
- void ILI9341_setInterface (void)

  Sets the interface for the ILI9341.

6.12.1 Detailed Description

Source code for ILI9341 module.

Author

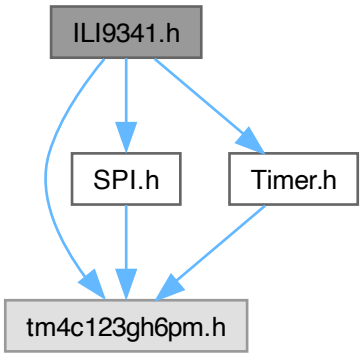
Bryan McElvy

6.13 ILI9341.h File Reference

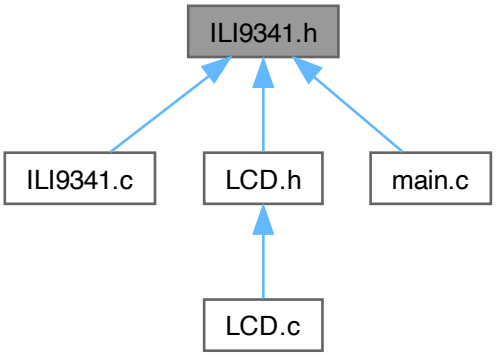
Driver module for interfacing with an ILI9341 LCD driver.

```
#include ¨tm4c123gh6pm.h¨
#include ¨SPI.h¨
#include ¨Timer.h¨
```

Include dependency graph for ILI9341.h:



This graph shows which files directly or indirectly include this file:



Macros

- #define **NOP** (uint8_t) 0x00
- #define **SWRESET** (uint8_t) 0x01
- #define **RDDST** (uint8_t) 0x09
- #define **RDDMADCTL** (uint8_t) 0x0B
- #define **RDDCOLMOD** (uint8_t) 0x0C
- #define **DINVOFF** (uint8_t) 0x20
- #define **DINVON** (uint8_t) 0x21
- #define **CASET** (uint8_t) 0x2A
- #define **PASET** (uint8_t) 0x2B
- #define **RAMWR** (uint8_t) 0x2C
- #define **RAMRD** (uint8_t) 0x2E
- #define **DISPOFF** (uint8_t) 0x28
- #define **DISPON** (uint8_t) 0x29
- #define **VSCRDEF** (uint8_t) 0x33
- #define **MADCTL** (uint8_t) 0x36
- #define **VSCRSADD** (uint8_t) 0x37
- #define **PIXSET** (uint8_t) 0x3A
- #define **WRDISBV** (uint8_t) 0x51
- #define **RDDISBV** (uint8_t) 0x52
- #define **IFMODE** (uint8_t) 0xB0
- #define **FRMCTR1** (uint8_t) 0xB1
- #define **PRCTR** (uint8_t) 0xB5
- #define **IFCTL** (uint8_t) 0xF6
- #define **NUM_COLS** (uint8_t) 240
- #define **NUM_ROWS** (uint8_t) 320

Functions

- void ILI9341_Init (void)

  Initialize the LCD driver.
- void ILI9341_ResetHard (void)

  Perform a hardware reset of the LCD driver.
- void ILI9341_ResetSoft (void)

  Perform a software reset of the LCD driver.
- void **ILI9341_NoOpCmd** (void)

  Send the "No Operation" command (NOP) to the LCD driver. Can be used to terminate the "Memory Write" and "Memory Read" commands (RAMWR and RAMRD, respectively), but does nothing otherwise.
- uint8_t * **ILI9341_getDispStatus** (void)
- uint8_t **ILI9341_getMemAccessCtrl** (void)
- void ILI9341_setRowAddress (uint16_t start_row, uint16_t end_row)

  Sets the start/end rows to be written to.
- void ILI9341_setColAddress (uint16_t start_col, uint16_t end_col)

  Sets the start/end rows to be written to.
- void **ILI9341_writeMemCmd** (void)

  Sends the "Write Memory" command (RAMWR). Should be used before ILI9341_write1px().
- void ILI9341_write1px (uint8_t data[3])

  Write a single pixel to memory. Should be used after ILI9341_writeMemCmd().
- void ILI9341_setDispInversion (uint8_t is_ON)

  Send command to toggle display display inversion.
- void ILI9341_setDisplayStatus (uint8_t is_ON)

  Send command to turn the display ON or OFF.
- void **ILI9341_setVertScrollArea** (uint16_t top_fixed, uint16_t vert_scroll, uint16_t bottom_fixed)
- void **ILI9341_setVertScrollStart** (uint16_t start_address)
- void **ILI9341_setMemAccessCtrl** (uint8_t row_address_order, uint8_t col_address_order, uint8_t row_col↩ _exchange, uint8_t vert_refresh_order, uint8_t rgb_order, uint8_t hor_refresh_order)
- void **ILI9341_setPixelFormat** (uint8_t is_16bit)
- void ILI9341_setDispBrightness (uint8_t brightness)

  Sets the brightness value of the display.
- uint8_t **ILI9341_getDispBrightness** (void)
- void ILI9341_setDispInterface (uint8_t param)

  Send command to set operation status of display interface.
- void **ILI9341_setFrameRate** (uint8_t div_ratio, uint8_t clocks_per_line)
- void **ILI9341_setBlankingPorch** (uint8_t vert_front_porch, uint8_t vert_back_porch, uint8_t hor_front_porch, uint8_t hor_back_porch)
- void ILI9341_setInterface (void)

  Sets the interface for the ILI9341.

6.13.1 Detailed Description

Driver module for interfacing with an ILI9341 LCD driver.

Author

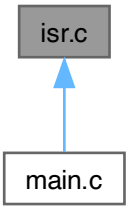
Bryan McElvy

This module contains functions for initializing and outputting graphical data to a 240RGBx320 resolution, 262K color-depth liquid crystal display (LCD). The module interfaces the LaunchPad (or any other board featuring the TM4C123GH6PM microcontroller) with an ILI9341 LCD driver chip via the SPI (serial peripheral interface) protocol.

6.14 isr.c File Reference

Source code for interrupt service routines (ISRs)

This graph shows which files directly or indirectly include this file:



Functions

- void GPIO_PortF_Handler ()

  ISR for facilitating user control of program state.
- void SysTick_Handler ()

  ISR for collecting ECG samples @ f_s = 200 [Hz].
- void Timer1A_Handler ()

  ISR for updating the LCD @ f_s = 30 [Hz].

6.14.1 Detailed Description

Source code for interrupt service routines (ISRs)

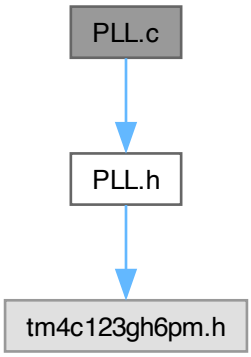
Author

Bryan McElvy

6.15 PLL.c File Reference

Implementation details for phase-lock-loop (PLL) functions.

`#include ¨PLL.h¨`
Include dependency graph for PLL.c:



Functions

- void PLL_Init (void)

  Initializes the phase-locked-loop (PLL), allowing a bus frequency of 80[MHz].

6.15.1 Detailed Description

Implementation details for phase-lock-loop (PLL) functions.

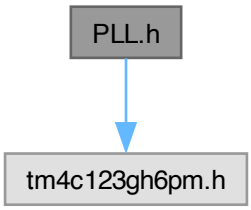
Author

Bryan McElvy

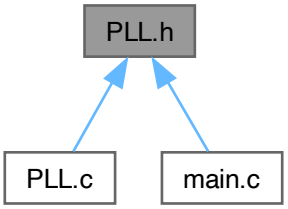
6.16 PLL.h File Reference

Driver module for activating the phase-locked-loop (PLL).

`#include ¨tm4c123gh6pm.h¨`
Include dependency graph for PLL.h:



This graph shows which files directly or indirectly include this file:



Functions

- void PLL_Init (void)

  Initializes the phase-locked-loop (PLL), allowing a bus frequency of 80[MHz].

6.16.1 Detailed Description

Driver module for activating the phase-locked-loop (PLL).

Author

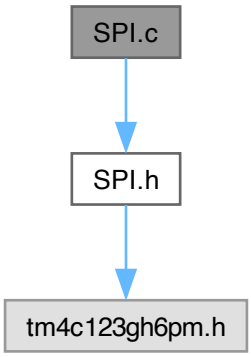
Bryan McElvy

6.17 SPI.c File Reference

Source code for SPI module.

```
#include ¨SPI.h¨
```

Include dependency graph for SPI.c:



Functions

- void SPI_Init (void)

  Initialize SSI0 to act as an SPI Controller (AKA Master) in mode 0.
- uint8_t SPI_Read (void)

  Read data from peripheral.
- void SPI_WriteCmd (uint8_t cmd)

  Write an 8-bit command to the peripheral.
- void SPI_WriteData (uint8_t data)

  Write 8-bit data to the peripheral.
- void SPI_WriteSequence (uint8_t cmd, uint8_t param_sequence[ ], uint8_t num_params)

  Write a sequence of data to the peripheral, with or without a preceding command.

6.17.1 Detailed Description

Source code for SPI module.

Author

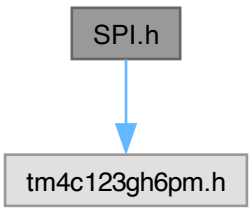
Bryan McElvy

6.18 SPI.h File Reference

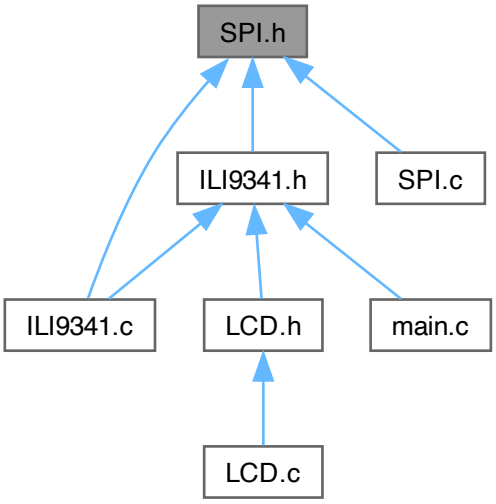
Driver module for using the serial peripheral interface (SPI) protocol.

```
#include ¨tm4c123gh6pm.h¨
```

Include dependency graph for SPI.h:



This graph shows which files directly or indirectly include this file:



Functions

- void SPI_Init (void)

  Initialize SSI0 to act as an SPI Controller (AKA Master) in mode 0.
- uint8_t SPI_Read (void)

  Read data from peripheral.
- void SPI_WriteCmd (uint8_t cmd)

  Write an 8-bit command to the peripheral.
- void SPI_WriteData (uint8_t data)

  Write 8-bit data to the peripheral.
- void SPI_WriteSequence (uint8_t cmd, uint8_t param_sequence[ ], uint8_t num_params)

  Write a sequence of data to the peripheral, with or without a preceding command.

6.18.1 Detailed Description

Driver module for using the serial peripheral interface (SPI) protocol.

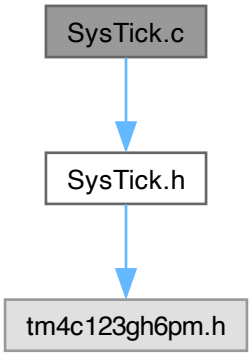
Author

Bryan McElvy

6.19 SysTick.c File Reference

Implementation details for SysTick functions.

```
#include ¨SysTick.h¨
```
Include dependency graph for SysTick.c:



Functions

- void SysTick_Timer_Init (void)

  Initialize SysTick for timing purposes.
- void **SysTick_Wait1ms** (uint32_t time_ms)

  Delay for specified amount of time in [ms]. Assumes f_bus = 80[MHz].
- void SysTick_Interrupt_Init (uint32_t time_ms)

  Initialize SysTick for interrupts.

6.19.1 Detailed Description

Implementation details for SysTick functions.

Author

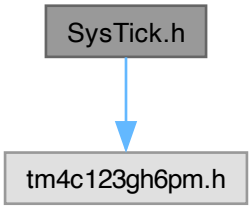
Bryan McElvy

6.20 SysTick.h File Reference

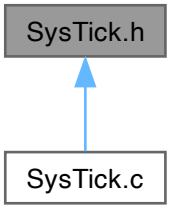
Driver module for using SysTick-based timing and/or interrupts.

```
#include ¨tm4c123gh6pm.h¨
```

Include dependency graph for SysTick.h:



This graph shows which files directly or indirectly include this file:



Functions

- void SysTick_Timer_Init (void)

  Initialize SysTick for timing purposes.
- void **SysTick_Wait1ms** (uint32_t delay_ms)

  Delay for specified amount of time in [ms]. Assumes f_bus = 80[MHz].
- void SysTick_Interrupt_Init (uint32_t time_ms)

  Initialize SysTick for interrupts.

6.20.1 Detailed Description

Driver module for using SysTick-based timing and/or interrupts.

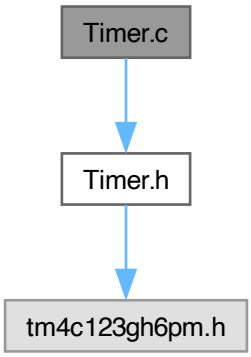
Author

Bryan McElvy

6.21 Timer.c File Reference

Implementation for timer module.

`#include ¨Timer.h¨`
Include dependency graph for Timer.c:



Functions

- void Timer0A_Init (void)
  Initialize timer 0 as 32-bit, one-shot, countdown timer.
- void Timer0A_Start (uint32_t time_ms)
  Count down starting from the inputted value.
- uint8_t Timer0A_isCounting (void)
  Returns 1 if Timer0 is still counting and 0 if not.
- void Timer0A_Wait1ms (uint32_t time_ms)
  Wait for the specified amount of time in [ms].
- void Timer1A_Init (uint32_t time_ms)
  Initialize timer 1 as a 32-bit, periodic, countdown timer with interrupts.
- void Timer2A_Init (void)
  Initialize timer 2 as 32-bit, one-shot, countdown timer.
- void Timer2A_Start (uint32_t time_ms)
  Count down starting from the inputted value.
- uint8_t Timer2A_isCounting (void)
  Returns 1 if Timer2 is still counting and 0 if not.
- void Timer2A_Wait1ms (uint32_t time_ms)
  Wait for the specified amount of time in [ms].

6.21.1 Detailed Description

Implementation for timer module.

Author

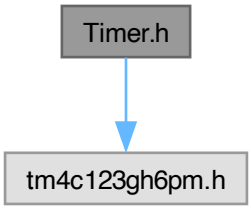
Bryan McElvy

6.22 Timer.h File Reference

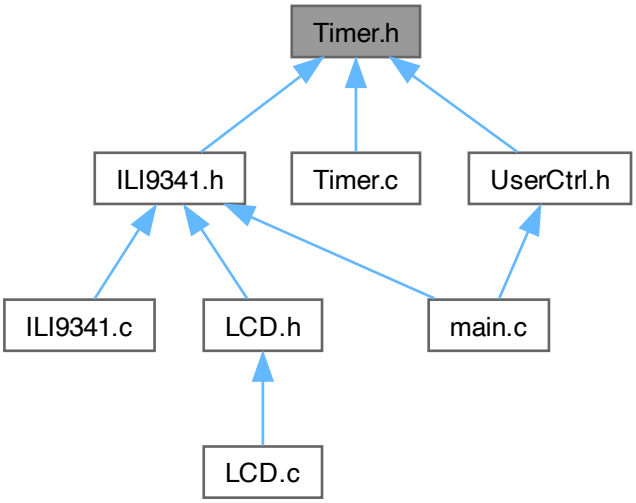
Driver module for timing (Timer0) and interrupts (Timer1).

```
#include ¨tm4c123gh6pm.h¨
```

Include dependency graph for Timer.h:



This graph shows which files directly or indirectly include this file:



Functions

- void Timer0A_Init (void)

  Initialize timer 0 as 32-bit, one-shot, countdown timer.
- void Timer0A_Start (uint32_t time_ms)

  Count down starting from the inputted value.
- uint8_t Timer0A_isCounting (void)

Returns 1 if Timer0 is still counting and 0 if not.

- void Timer0A_Wait1ms (uint32_t time_ms)

  Wait for the specified amount of time in [ms].
- void Timer1A_Init (uint32_t time_ms)

  Initialize timer 1 as a 32-bit, periodic, countdown timer with interrupts.
- void Timer2A_Init (void)

  Initialize timer 2 as 32-bit, one-shot, countdown timer.
- void Timer2A_Start (uint32_t time_ms)

  Count down starting from the inputted value.
- uint8_t Timer2A_isCounting (void)

  Returns 1 if Timer2 is still counting and 0 if not.
- void Timer2A_Wait1ms (uint32_t time_ms)

  Wait for the specified amount of time in [ms].

6.22.1 Detailed Description

Driver module for timing (Timer0) and interrupts (Timer1).

Author

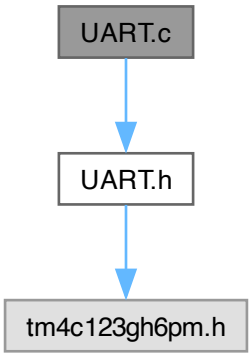
Bryan McElvy

6.23 UART.c File Reference

Source code for UART module.

```
#include ¨UART.h¨
```

Include dependency graph for UART.c:



Functions

- void UART0_Init (void)

  Initialize UART0 to a baud rate of 115200, 8-bit data length, 1 start bit, and 1 stop bit.
- unsigned char UART0_ReadChar (void)

  Read a single character from UART0.
- void UART0_WriteChar (unsigned char input_char)

  Write a single character to UART0.
- void UART0_WriteStr (unsigned char ∗str_ptr)

  Write a C string to UART0.
- void UART1_Init (void)

  Initialize UART1 to a baud rate of 115200, 8-bit data length, 1 start bit, and 1 stop bit.
- unsigned char UART1_ReadChar (void)

  Read a single character from UART1.
- void UART1_WriteChar (unsigned char input_char)

  Write a single character to UART1.
- void UART1_WriteStr (unsigned char ∗str_ptr)

  Write a C string to UART1.

6.23.1 Detailed Description

Source code for UART module.

Author

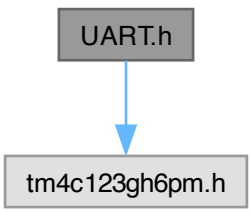
Bryan McElvy

6.24 UART.h File Reference

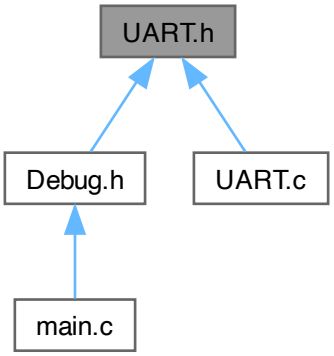
Driver module for serial communication via UART0 and UART 1.

```
#include ¨tm4c123gh6pm.h¨
```

Include dependency graph for UART.h:



This graph shows which files directly or indirectly include this file:



Functions

- void UART0_Init (void)

  Initialize UART0 to a baud rate of 115200, 8-bit data length, 1 start bit, and 1 stop bit.
- unsigned char UART0_ReadChar (void)

  Read a single character from UART0.
- void UART0_WriteChar (unsigned char input_char)

  Write a single character to UART0.
- void UART0_WriteStr (unsigned char ∗str_ptr)

  Write a C string to UART0.
- void UART1_Init (void)

  Initialize UART1 to a baud rate of 115200, 8-bit data length, 1 start bit, and 1 stop bit.
- unsigned char UART1_ReadChar (void)

  Read a single character from UART1.
- void UART1_WriteChar (unsigned char input_char)

  Write a single character to UART1.
- void UART1_WriteStr (unsigned char ∗str_ptr)

  Write a C string to UART1.

6.24.1 Detailed Description

Driver module for serial communication via UART0 and UART 1.

Author

Bryan McElvy

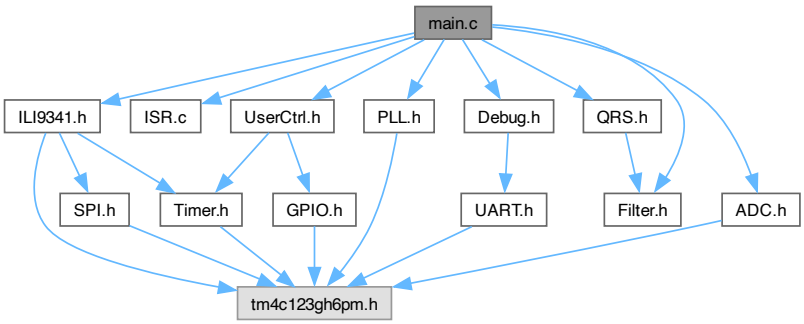
```
UART0 uses PA0 and PA1, which are not broken out but do connect
to a PC's serial port via USB.

UART1 uses PB0 (Rx) and PB1 (Tx), which are not broken out but
do not connect to a serial port.
```

6.25 main.c File Reference

Main program file for ECG-HRM.

```
#include ¨ADC.h¨
#include ¨ISR.c¨
#include ¨ILI9341.h¨
#include ¨PLL.h¨
#include ¨Debug.h¨
#include ¨Filter.h¨
#include ¨QRS.h¨
#include ¨UserCtrl.h¨
```

Include dependency graph for main.c:



Functions

- int **main** (void)

6.25.1 Detailed Description

Main program file for ECG-HRM.

Author

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