

e-Tech Racing's Inverter Firmware

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Source file for torque reference handling	224
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This file provides code for the MSP Initialization and de-Initialization codes	227
C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/ stm32f7xx_it.c	
Interrupt Service Routines	228
C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/ syscalls.c	
STM32CubeIDE Minimal System calls file	233
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STM32CubeIDE System Memory calls file	238
C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/ system_stm32f7xx.c	
CMSIS Cortex-M7 Device Peripheral Access Layer System Source File	239
C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/ TASKS_1ms.c	
This file contains functions to execute tasks every 1ms	241
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This file contains functions executed every 20us in each PWM timer interruption	242
C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/ tim.c	
This file provides code for the configuration of the TIM instances	245
C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/ usb_otg.c	
This file provides code for the configuration of the USB_OTG instances	252

Chapter 4

Topic Documentation

4.1 Math Constants

Macros

- #define **SQ2** 1.4142135624F
- #define **ISQ2** 0.7071067812F
- #define **SQ3** 1.7320508076F
- #define **ISQ3** 0.5773502692F
- #define **PI** 3.1415926536F
- #define **IPI** 0.3183098862F
- #define **PI2** 6.2831853072F
- #define **IPI2** 0.1591549431F
- #define **INV_DEG** 0.0027777778F
- #define **INV3** 0.3333333333F
- #define **DIV2** 0.5F

4.1.1 Detailed Description

4.1.2 Macro Definition Documentation

4.1.2.1 DIV2

```
#define DIV2 0.5F
```

1/2

4.1.2.2 INV3

```
#define INV3 0.3333333333F
```

Inverse of 3

4.1.2.3 INV_DEG

```
#define INV_DEG 0.002777778F
```

Inverse of 360

4.1.2.4 IPI

```
#define IPI 0.3183098862F
```

Inverse of Pi

4.1.2.5 IPI2

```
#define IPI2 0.1591549431F
```

Inverse of (2*Pi)

4.1.2.6 ISQ2

```
#define ISQ2 0.7071067812F
```

Inverse of square root of 2

4.1.2.7 ISQ3

```
#define ISQ3 0.5773502692F
```

Inverse of square root of 3

4.1.2.8 PI

```
#define PI 3.1415926536F
```

Pi

4.1.2.9 PI2

```
#define PI2 6.2831853072F
```

2*Pi

4.1.2.10 SQ2

```
#define SQ2 1.4142135624F
```

Square root of 2

4.1.2.11 SQ3

```
#define SQ3 1.7320508076F
```

Square root of 3

4.2 - Integral Controllers

Data Structures

- struct [pi_aw_struct](#)
PI Controller with internal saturation, anti-windup, and feedforward.
- struct [pi_struct](#)
PI Controller with external saturation and feedforward.

Functions

- void [pi_aw_calc](#) (volatile [pi_aw_struct](#) *v) [__attribute__\(\(section\(".ccmram"\)\)\)](#)
Initializes the PI controller with anti-windup.
- void [pi_init](#) (volatile [pi_struct](#) *v) [__attribute__\(\(section\(".ccmram"\)\)\)](#)
Initializes the PI controller.
- void [pi_calc](#) (volatile [pi_struct](#) *v) [__attribute__\(\(section\(".ccmram"\)\)\)](#)
Calculates the output of the PI controller.
- void [pi_extsat_calc](#) (volatile [pi_struct](#) *v)
Calculates the output of the PI controller with external saturation.

4.2.1 Detailed Description

4.2.2 Function Documentation

4.2.2.1 [pi_aw_calc\(\)](#)

```
void pi_aw_calc (
    volatile pi\_aw\_struct * v )
```

Initializes the PI controller with anti-windup.

Parameters

v	Pointer to the PI controller structure.
---	---

Initializes the PI controller with anti-windup.

Parameters

v	Pointer to the PI control structure.
---	--------------------------------------

Note

This function computes the PI control action with anti-windup.

4.2.2.2 pi_calc()

```
void pi_calc (
    volatile pi_struct * v )
```

Calculates the output of the PI controller.

Parameters

v	Pointer to the PI controller structure.
---	---

Calculates the output of the PI controller.

Parameters

v	Pointer to the PI structure.
---	------------------------------

Note

This function computes the PI control action with feedforward and saturation.

Here is the caller graph for this function:



4.2.2.3 pi_extsat_calc()

```
void pi_extsat_calc (
    volatile pi_struct * v )
```

Calculates the output of the PI controller with external saturation.

Parameters

v	Pointer to the PI controller structure.
---	---

Calculates the output of the PI controller with external saturation.

Parameters

v	Pointer to the PI structure.
---	------------------------------

Note

This function computes the PI control action without saturation for external saturation.

4.2.2.4 pi_init()

```
void pi_init (
    volatile pi_struct * v )
```

Initializes the PI controller.

Parameters

v	Pointer to the PI controller structure.
---	---

Initializes the PI controller.

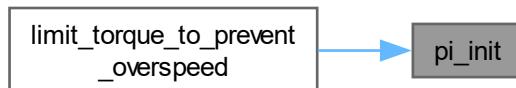
Parameters

v	Pointer to the PI structure.
---	------------------------------

Note

This function initializes the constants used in the PI controller.

Here is the caller graph for this function:



4.3 Clarke and Park Transformations

Data Structures

- struct [clarke3F_struct](#)

- struct `clarke3F_struct`

Clarke transformation for three-phase systems.
- struct `rot_struct`

Inverse Clarke transformation for three-phase systems.
- struct `irot_struct`

Rotates the DQ axis in the opposite direction (clockwise).
- struct `irot_struct`

Inverse rotation (counterclockwise).

Functions

- void `clarke3F_calc` (volatile `clarke3F_struct` **v*) `__attribute__((section(".ccmram")))`

Calculates the Clarke transformation.
- void `iclarke3F_calc` (volatile `clarke3F_struct` **v*)

Calculates the inverse Clarke transformation.
- void `rot_calc` (volatile `rot_struct` **v*) `__attribute__((section(".ccmram")))`

Calculates the rotation in the opposite direction.
- void `irot_calc` (volatile `irot_struct` **v*) `__attribute__((section(".ccmram")))`

Calculates the inverse rotation.

4.3.1 Detailed Description

4.3.2 Function Documentation

4.3.2.1 clarke3F_calc()

```
void clarke3F_calc (
    volatile clarke3F_struct * v )
```

Calculates the Clarke transformation.

Parameters

<code>v</code>	Pointer to the Clarke transformation structure.
----------------	---

Calculates the Clarke transformation.

Parameters

<code>v</code>	Pointer to the Clarke transformation structure.
----------------	---

Note

This function computes the Clarke transformation for three-phase signals.

4.3.2.2 iclarke3F_calc()

```
void iclarke3F_calc (
    volatile iclarke3F_struct * v )
```

Calculates the inverse Clarke transformation.

Parameters

v	Pointer to the inverse Clarke transformation structure.
---	---

Calculates the inverse Clarke transformation.

Parameters

v	Pointer to the inverse Clarke transformation structure.
---	---

Note

This function computes the inverse Clarke transformation for three-phase signals.

4.3.2.3 irot_calc()

```
void irot_calc (
    volatile irot_struct * v )
```

Calculates the inverse rotation.

Parameters

v	Pointer to the inverse rotation structure.
---	--

Calculates the inverse rotation.

Parameters

v	Pointer to the inverse rotation transformation structure.
---	---

Note

This function computes the inverse rotation transformation (counterclockwise).

4.3.2.4 rot_calc()

```
void rot_calc (
    volatile rot_struct * v )
```

Calculates the rotation in the opposite direction.

Parameters

v	Pointer to the rotation structure.
---	------------------------------------

Calculates the rotation in the opposite direction.

Parameters

v	Pointer to the rotation transformation structure.
---	---

Note

This function computes the rotation transformation (clockwise).

4.4 Utility Functions

Data Structures

- struct `angle_struct`
Generates an angle based on a fixed frequency.
- struct `svpwm_struct`
Space Vector Pulse Width Modulation (SVPWM) implementation.

Functions

- void `angle_calc` (volatile `angle_struct` *p) `__attribute__((section(".ccmram")))`
Calculates the angle generation.
- void `svpwm_calc` (volatile `svpwm_struct` *v) `__attribute__((section(".ccmram")))`
Calculates the SVPWM outputs.

4.4.1 Detailed Description

4.4.2 Function Documentation

4.4.2.1 `angle_calc()`

```
void angle_calc (
    volatile angle_struct * v )
```

Calculates the angle generation.

Parameters

p	Pointer to the angle structure.
---	---------------------------------

Calculates the angle generation.

Parameters

v	Pointer to the angle generation structure.
---	--

Note

This function generates the angle.

Here is the caller graph for this function:



4.4.2.2 svpwm_calc()

```
void svpwm_calc (
    volatile svpwm_struct * v )
```

Calculates the SVPWM outputs.

Parameters

v	Pointer to the SVPWM structure.
---	---------------------------------

Calculates the SVPWM outputs.

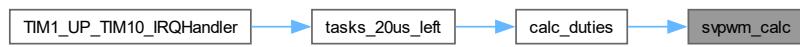
Parameters

v	Pointer to the SVPWM structure.
---	---------------------------------

Note

This function calculates the Space Vector Pulse Width Modulation (SVPWM).

Here is the caller graph for this function:



4.5 Signal Processing Functions

Data Structures

- struct rampa_struct

- struct `rampa_dual_struct`
 - Single-ramp generator.*
- struct `datalog_struct`
 - Dual-ramp generator.*
- struct `avg_struct_10`
 - Moving average filter for 10 samples.*
- struct `RMS_struct`
 - Root Mean Square (RMS) calculation.*
- struct `filtreLP_struct`
 - First-order low-pass filter.*

Macros

- `#define N_DATALOG 256`
 - Data logger for logging variables.*

Functions

- void `rampa_calc` (volatile `rampa_struct` *v) `__attribute__((section(".ccmram")))`
 - Calculates the output of the single ramp generator.*
- void `rampa_dual_calc` (volatile `rampa_dual_struct` *v) `__attribute__((section(".ccmram")))`
 - Calculates the output of the dual ramp generator.*
- void `datalog_calc` (volatile `datalog_struct` *dl)
 - Calculates the data log.*
- void `avg_calc_10_samples` (volatile `avg_struct_10` *v)
 - Calculates the moving average for 10 samples.*
- void `RMS_calc` (volatile `RMS_struct` *v) `__attribute__((section(".ccmram")))`
 - Calculates the RMS.*
- void `filtreLP_init` (volatile `filtreLP_struct` *v)
 - Initializes the first-order low-pass filter.*
- void `filtreLP_calc` (volatile `filtreLP_struct` *v) `__attribute__((section(".ccmram")))`
 - Calculates the output of the first-order low-pass filter.*

4.5.1 Detailed Description

4.5.2 Macro Definition Documentation

4.5.2.1 N_DATALOG

```
#define N_DATALOG 256
```

Data logger for logging variables.

Number of samples for the data log

4.5.3 Function Documentation

4.5.3.1 avg_calc_10_samples()

```
void avg_calc_10_samples (
    volatile avg_struct_10 * v )
```

Calculates the moving average for 10 samples.

Parameters

v	Pointer to the moving average structure.
---	--

Calculates the moving average for 10 samples.

Parameters

v	Pointer to the structure containing the samples.
---	--

Note

This function calculates the average of 10 samples.

4.5.3.2 `datalog_calc()`

```
void datalog_calc (
    volatile datalog\_struct * dl )
```

Calculates the data log.

Parameters

dl	Pointer to the data log structure.
dl	Pointer to the data log structure.

Note

This function calculates the data log.

4.5.3.3 `filtreLP_calc()`

```
void filtreLP_calc (
    volatile filtreLP\_struct * v )
```

Calculates the output of the first-order low-pass filter.

Parameters

v	Pointer to the filter structure.
---	----------------------------------

Calculates the output of the first-order low-pass filter.

Parameters

v	Pointer to the first-order filter structure.
---	--

Note

This function calculates the first-order filter.

4.5.3.4 `filtreLP_init()`

```
void filtreLP_init (
    volatile filtreLP_struct * v )
```

Initializes the first-order low-pass filter.

Parameters

<code>v</code>	Pointer to the filter structure.
----------------	----------------------------------

Initializes the first-order low-pass filter.

Parameters

<code>v</code>	Pointer to the first-order filter structure.
----------------	--

Note

This function initializes the first-order filter.

4.5.3.5 `rampa_calc()`

```
void rampa_calc (
    volatile rampa_struct * v )
```

Calculates the output of the single ramp generator.

Parameters

<code>v</code>	Pointer to the single ramp generator structure.
----------------	---

Calculates the output of the single ramp generator.

Parameters

<code>v</code>	Pointer to the ramp structure.
----------------	--------------------------------

Note

This function calculates the ramp.

4.5.3.6 rampa_dual_calc()

```
void rampa_dual_calc (
    volatile rampa_dual_struct * v )
```

Calculates the output of the dual ramp generator.

Parameters

v	Pointer to the dual ramp generator structure.
---	---

Calculates the output of the dual ramp generator.

Parameters

v	Pointer to the dual ramp structure.
---	-------------------------------------

Note

This function calculates the dual ramp.

4.5.3.7 RMS_calc()

```
void RMS_calc (
    volatile RMS_struct * v )
```

Calculates the RMS.

Parameters

v	Pointer to the RMS structure.
---	-------------------------------

Calculates the RMS.

Parameters

v	Pointer to the RMS structure.
---	-------------------------------

Note

This function calculates the Root Mean Square (RMS).

4.6 Miscellaneous Functions

Data Structures

- struct `step_struct`

Step function generator.

Functions

- void [step_calc](#) (volatile [step_struct](#) *v) [__attribute__](#)((section(".ccmram"))))
Calculates the output of the step function generator.

4.6.1 Detailed Description

4.6.2 Function Documentation

4.6.2.1 [step_calc\(\)](#)

```
void step_calc (
    volatile step\_struct * v )
```

Calculates the output of the step function generator.

Parameters

v	Pointer to the step generator structure.
-------------------	--

Calculates the output of the step function generator.

Parameters

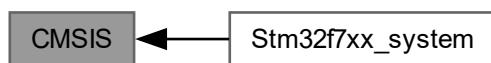
v	Pointer to the step structure.
-------------------	--------------------------------

Note

This function calculates the step function.

4.7 CMSIS

Collaboration diagram for CMSIS:



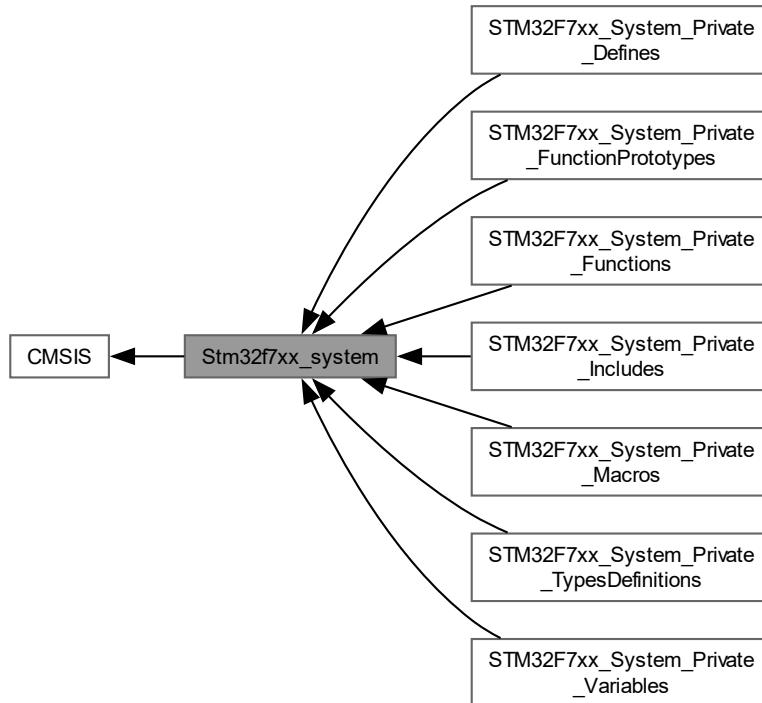
Topics

- [Stm32f7xx_system](#)

4.7.1 Detailed Description

4.7.2 Stm32f7xx_system

Collaboration diagram for Stm32f7xx_system:



Topics

- [STM32F7xx_System_Private_Includes](#)
- [STM32F7xx_System_Private_TypesDefinitions](#)
- [STM32F7xx_System_Private_Defines](#)
- [STM32F7xx_System_Private_Macros](#)
- [STM32F7xx_System_Private_Variables](#)
- [STM32F7xx_System_Private_FunctionPrototypes](#)
- [STM32F7xx_System_Private_Functions](#)

4.7.2.1 Detailed Description

4.7.2.2 STM32F7xx_System_Private_Includes

Collaboration diagram for STM32F7xx_System_Private_Includes:



Macros

- `#define HSE_VALUE ((uint32_t)25000000)`
- `#define HSI_VALUE ((uint32_t)16000000)`

4.7.2.2.1 Detailed Description

4.7.2.2.2 Macro Definition Documentation

4.7.2.2.2.1 HSE_VALUE

```
#define HSE_VALUE ((uint32_t)25000000)
```

Default value of the External oscillator in Hz

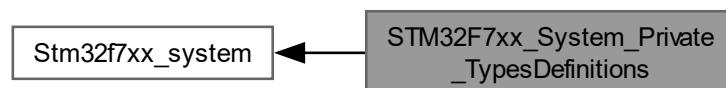
4.7.2.2.2.2 HSI_VALUE

```
#define HSI_VALUE ((uint32_t)16000000)
```

Value of the Internal oscillator in Hz

4.7.2.3 STM32F7xx_System_Private_TypesDefinitions

Collaboration diagram for STM32F7xx_System_Private_TypesDefinitions:



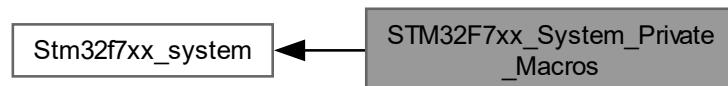
4.7.2.4 STM32F7xx_System_Private_Defines

Collaboration diagram for STM32F7xx_System_Private_Defines:



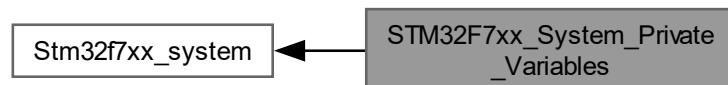
4.7.2.5 STM32F7xx_System_Private_Macros

Collaboration diagram for STM32F7xx_System_Private_Macros:



4.7.2.6 STM32F7xx_System_Private_Variables

Collaboration diagram for STM32F7xx_System_Private_Variables:



Variables

- `uint32_t SystemCoreClock = 16000000`
- `const uint8_t AHBPrescTable [16] = {0, 0, 0, 0, 0, 0, 0, 0, 1, 2, 3, 4, 6, 7, 8, 9}`
- `const uint8_t APBPrescTable [8] = {0, 0, 0, 0, 1, 2, 3, 4}`

4.7.2.6.1 Detailed Description

4.7.2.6.2 Variable Documentation

4.7.2.6.2.1 AHBPrescTable

```
const uint8_t AHBPrescTable[16] = {0, 0, 0, 0, 0, 0, 0, 0, 1, 2, 3, 4, 6, 7, 8, 9}
```

4.7.2.6.2.2 APBPrescTable

```
const uint8_t APBPrescTable[8] = {0, 0, 0, 0, 1, 2, 3, 4}
```

4.7.2.6.2.3 SystemCoreClock

```
uint32_t SystemCoreClock = 16000000
```

4.7.2.7 STM32F7xx_System_Private_FunctionPrototypes

Collaboration diagram for STM32F7xx_System_Private_FunctionPrototypes:



4.7.2.8 STM32F7xx_System_Private_Functions

Collaboration diagram for STM32F7xx_System_Private_Functions:



Functions

- void [SystemInit](#) (void)
Setup the microcontroller system Initialize the Embedded Flash Interface, the PLL and update the SystemFrequency variable.
- void [SystemCoreClockUpdate](#) (void)
Update SystemCoreClock variable according to Clock Register Values. The SystemCoreClock variable contains the core clock (HCLK), it can be used by the user application to setup the SysTick timer or configure other parameters.

4.7.2.8.1 Detailed Description

4.7.2.8.2 Function Documentation

4.7.2.8.2.1 SystemCoreClockUpdate()

```
void SystemCoreClockUpdate (
    void )
```

Update SystemCoreClock variable according to Clock Register Values. The SystemCoreClock variable contains the core clock (HCLK), it can be used by the user application to setup the SysTick timer or configure other parameters.

Note

Each time the core clock (HCLK) changes, this function must be called to update SystemCoreClock variable value. Otherwise, any configuration based on this variable will be incorrect.

- The system frequency computed by this function is not the real frequency in the chip. It is calculated based on the predefined constant and the selected clock source:

- If SYSCLK source is HSI, SystemCoreClock will contain the [HSI_VALUE\(*\)](#)
- If SYSCLK source is HSE, SystemCoreClock will contain the [HSE_VALUE\(**\)](#)
- If SYSCLK source is PLL, SystemCoreClock will contain the [HSE_VALUE\(**\)](#) or [HSI_VALUE\(*\)](#) multiplied/divided by the PLL factors.

(*) HSI_VALUE is a constant defined in [stm32f7xx_hal_conf.h](#) file (default value 16 MHz) but the real value may vary depending on the variations in voltage and temperature.

(**) HSE_VALUE is a constant defined in [stm32f7xx_hal_conf.h](#) file (default value 25 MHz), user has to ensure that HSE_VALUE is same as the real frequency of the crystal used. Otherwise, this function may have wrong result.

- The result of this function could be not correct when using fractional value for HSE crystal.

Parameters

None	<input type="button" value=""/>
----------------------	---------------------------------

Return values

<i>None</i>	<input type="button" value=""/>
-------------	---------------------------------

4.7.2.8.2.2 SystemInit()

```
void SystemInit (
    void )
```

Setup the microcontroller system Initialize the Embedded Flash Interface, the PLL and update the SystemFrequency variable.

Parameters

<i>None</i>	<input type="button" value=""/>
-------------	---------------------------------

Return values

<i>None</i>	<input type="button" value=""/>
-------------	---------------------------------

Chapter 5

Data Structure Documentation

5.1 Analog Struct Reference

Structure for ADC measurements in units.

```
#include <MEASUREMENTS.h>
```

Data Fields

- float `ia`
- float `ib`
- float `ic`
- float `vDC`

5.1.1 Detailed Description

Structure for ADC measurements in units.

5.1.2 Field Documentation

5.1.2.1 `ia`

```
float ia
```

Phase A current in A

5.1.2.2 `ib`

```
float ib
```

Phase B current in A

5.1.2.3 ic

```
float ic
```

Phase C current in A

5.1.2.4 vDC

```
float vDC
```

DC link voltage in V

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/[MEASUREMENTS.h](#)

5.2 angle_struct Struct Reference

Generates an angle based on a fixed frequency.

```
#include <PergaMOD.h>
```

Data Fields

- float freq
- float Ts
- float angle
- void(* calc)()

5.2.1 Detailed Description

Generates an angle based on a fixed frequency.

5.2.2 Field Documentation

5.2.2.1 angle

```
float angle
```

Network angle

5.2.2.2 calc

```
void(* calc) ()
```

Pointer to the calculation function

5.2.2.3 freq

```
float freq
```

Frequency of the network

5.2.2.4 Ts

```
float Ts
```

Execution frequency of the angle integration

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/[PergaMOD.h](#)

5.3 avg_struct_10 Struct Reference

Moving average filter for 10 samples.

```
#include <PergaMOD.h>
```

Data Fields

- float [out](#)
- float [in](#)[10]

5.3.1 Detailed Description

Moving average filter for 10 samples.

5.3.2 Field Documentation

5.3.2.1 in

```
float in[10]
```

Input and past samples

5.3.2.2 out

```
float out
```

Output variable

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/[PergaMOD.h](#)

5.4 clarke3F_struct Struct Reference

Clarke transformation for three-phase systems.

```
#include <PergaMOD.h>
```

Data Fields

- float `a`
- float `b`
- float `D`
- float `Q`
- void(* `calc`)()

5.4.1 Detailed Description

Clarke transformation for three-phase systems.

5.4.2 Field Documentation

5.4.2.1 `a`

```
float a
```

Phase A input

5.4.2.2 `b`

```
float b
```

Phase B input

5.4.2.3 `calc`

```
void(* calc) ()
```

Pointer to the calculation function

5.4.2.4 `D`

```
float D
```

D-axis output

5.4.2.5 Q

float Q

Q-axis output

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/PergaMOD.h

5.5 **datalog_struct** Struct Reference

```
#include <PergaMOD.h>
```

Data Fields

- uint16_t i
- uint16_t j
- uint16_t estat
- uint16_t prescaler
- float * var
- void(* calc)()
- float log [N_DATALOG]

5.5.1 Field Documentation

5.5.1.1 calc

```
void(* calc) ()
```

Pointer to the calculation function

5.5.1.2 estat

```
uint16_t estat
```

State: 0=stopped, 1=init, 2=running

5.5.1.3 i

```
uint16_t i
```

State variable

5.5.1.4 **j**

```
uint16_t j
```

State variable

5.5.1.5 **log**

```
float log[N_DATALOG]
```

Log array

5.5.1.6 **prescaler**

```
uint16_t prescaler
```

Prescaler

5.5.1.7 **var**

```
float* var
```

Pointer to variables

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/[PergaMOD.h](#)

5.6 Duties Struct Reference

Structure to hold PWM configuration parameters.

```
#include <PWM.h>
```

Data Fields

- float [Da](#)
- float [Db](#)
- float [Dc](#)

5.6.1 Detailed Description

Structure to hold PWM configuration parameters.

5.6.2 Field Documentation

5.6.2.1 Da

```
float Da
```

Duty cycle for channel 1

5.6.2.2 Db

```
float Db
```

Duty cycle for channel 2

5.6.2.3 Dc

```
float Dc
```

Duty cycle for channel 3

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/[PWM.h](#)

5.7 Encoder Struct Reference

Structure for encoder reading.

```
#include <MEASUREMENTS.h>
```

Data Fields

- `uint16_t A`
- `uint16_t B`
- `uint16_t Z`
- `float we`
- `float theta_e`
- `uint8_t direction_meas`

5.7.1 Detailed Description

Structure for encoder reading.

5.7.2 Field Documentation

5.7.2.1 A

uint16_t A

Encoder channel A value

5.7.2.2 B

uint16_t B

Encoder channel B value

5.7.2.3 direction_meas

uint8_t direction_meas

Measured direction

5.7.2.4 theta_e

float theta_e

Electrical rotor position

5.7.2.5 we

float we

Electrical angular velocity

5.7.2.6 Z

uint16_t Z

Encoder channel Z value

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/[MEASUREMENTS.h](#)

5.8 Feedback Struct Reference

Structure for feedback values.

```
#include <MEASUREMENTS.h>
```

Data Fields

- float `id_meas`
- float `iq_meas`
- float `torque_calc`
- float `speed_meas`

5.8.1 Detailed Description

Structure for feedback values.

5.8.2 Field Documentation

5.8.2.1 `id_meas`

`float id_meas`

Measured d-axis current in A

5.8.2.2 `iq_meas`

`float iq_meas`

Measured q-axis current in A

5.8.2.3 `speed_meas`

`float speed_meas`

Measured speed in RPM

5.8.2.4 `torque_calc`

`float torque_calc`

Calculated torque in N·m

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/[MEASUREMENTS.h](#)

5.9 **filtreLP_struct** Struct Reference

First-order low-pass filter.

```
#include <PergaMOD.h>
```

Data Fields

- float `in`
- float `out`
- float `alfa`
- float `Ts`
- float `fc`
- uint16_t `enable`
- void(* `init`)()
- void(* `calc`)()

5.9.1 Detailed Description

First-order low-pass filter.

5.9.2 Field Documentation

5.9.2.1 `alfa`

float `alfa`

Filter coefficient

5.9.2.2 `calc`

void(* `calc`) ()

Pointer to the calculation function

5.9.2.3 `enable`

uint16_t `enable`

Enable flag

5.9.2.4 `fc`

float `fc`

Cutoff frequency

5.9.2.5 `in`

float `in`

Input signal

5.9.2.6 init

```
void(* init) ()
```

Pointer to the initialization function

5.9.2.7 out

```
float out
```

Output signal

5.9.2.8 Ts

```
float Ts
```

Execution period

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/PergaMOD.h

5.10 iclarke3F_struct Struct Reference

Inverse Clarke transformation for three-phase systems.

```
#include <PergaMOD.h>
```

Data Fields

- float D
- float Q
- float a
- float b
- void(* calc)()

5.10.1 Detailed Description

Inverse Clarke transformation for three-phase systems.

5.10.2 Field Documentation

5.10.2.1 a

```
float a
```

Phase A output

5.10.2.2 b

float b

Phase B output

5.10.2.3 calc

void(* calc) ()

Pointer to the calculation function

5.10.2.4 D

float D

D-axis input

5.10.2.5 Q

float Q

Q-axis input

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

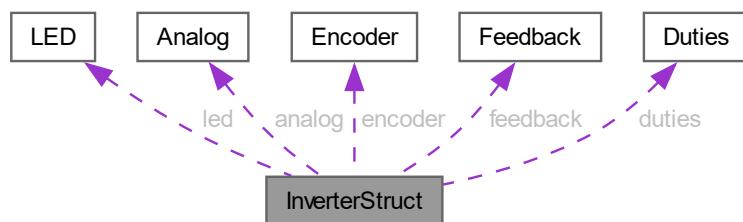
- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/PergaMOD.h

5.11 InverterStruct Struct Reference

Inverter structure.

```
#include <INVERTER.h>
```

Collaboration diagram for InverterStruct:



Data Fields

- `LED * led`
- `GPIO_TypeDef * enable_port`
- `uint16_t enable_pin`
- `TIM_HandleTypeDef * htim`
- `ADC_HandleTypeDef * hadc`
- `InverterState state`
- `Analog analog`
- `Encoder encoder`
- `Feedback feedback`
- `Duties duties`
- `int8_t direction`
- `float temp_inverter`
- `float temp_motor`

5.11.1 Detailed Description

Inverter structure.

5.11.2 Field Documentation

5.11.2.1 `analog`

`Analog analog`

Structure for phase currents and DC voltage measurements

5.11.2.2 `direction`

`int8_t direction`

Motor direction: 1 CW, -1 CCW, 0 stopped

5.11.2.3 `duties`

`Duties duties`

Structure for duty cycles for phases A, B, and C

5.11.2.4 `enable_pin`

`uint16_t enable_pin`

Pin number for enabling/disabling the inverter

5.11.2.5 enable_port

```
GPIO_TypeDef* enable_port
```

Pointer to GPIO port for enabling/disabling the inverter

5.11.2.6 encoder

```
Encoder encoder
```

Structure for encoder input

5.11.2.7 feedback

```
Feedback feedback
```

Structure for measured currents and calculated mechanical torque and speed

5.11.2.8 hadc

```
ADC_HandleTypeDef* hadc
```

Handle of the ADC peripheral for current phase currents and DC voltage sensing

5.11.2.9 htim

```
TIM_HandleTypeDef* htim
```

Handle of the timer peripheral for PWM output

5.11.2.10 led

```
LED* led
```

Pointer to [LED](#) control structure

5.11.2.11 state

```
InverterState state
```

Current state of inverter operation

5.11.2.12 temp_inverter

```
float temp_inverter
```

Semiconductor temperature in degC

5.11.2.13 temp_motor

```
float temp_motor
```

Motor temperature in degC

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/[INVERTER.h](#)

5.12 irot_struct Struct Reference

Inverse rotation (counterclockwise).

```
#include <PergaMOD.h>
```

Data Fields

- float [d](#)
- float [q](#)
- float [sinFi](#)
- float [cosFi](#)
- float [alpha](#)
- float [beta](#)
- void(* [calc](#))()

5.12.1 Detailed Description

Inverse rotation (counterclockwise).

5.12.2 Field Documentation

5.12.2.1 alpha

```
float alpha
```

alpha output

5.12.2.2 beta

```
float beta
```

beta output

5.12.2.3 calc

```
void(* calc) ()
```

Pointer to the calculation function

5.12.2.4 cosFi

```
float cosFi
```

Cosine of the angle of rotation

5.12.2.5 d

```
float d
```

D-axis input

5.12.2.6 q

```
float q
```

Q-axis input

5.12.2.7 sinFi

```
float sinFi
```

Sine of the angle of rotation

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/[PergaMOD.h](#)

5.13 LED Struct Reference

[LED](#) structure.

```
#include <PCB_IO.h>
```

Data Fields

- [GPIO_TypeDef * port](#)
- [uint16_t pin](#)
- [LEDMode mode](#)

5.13.1 Detailed Description

`LED` structure.

5.13.2 Field Documentation

5.13.2.1 mode

`LEDMode mode`

Current `LED` mode

5.13.2.2 pin

`uint16_t pin`

Pin number for controlling the `LED`

5.13.2.3 port

`GPIO_TypeDef* port`

GPIO port for controlling the `LED`

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/[PCB_IO.h](#)

5.14 motorParameters Struct Reference

Structure to hold motor parameters.

```
#include <MOTOR.h>
```

Data Fields

- float `Ld`
- float `Lq`
- float `Rs`
- float `lambda`
- int `pp`
- float `J`
- float `b`
- float `torque_max`
- float `dTorque_max`
- float `speed_max_RPM`
- float `iPhase_pk_max`
- float `vDC_max`

5.14.1 Detailed Description

Structure to hold motor parameters.

5.14.2 Field Documentation

5.14.2.1 b

```
float b
```

Viscous friction in N·m·s

5.14.2.2 dTorque_max

```
float dTorque_max
```

Maximum torque increment in N·m/s

5.14.2.3 iPhase_pk_max

```
float iPhase_pk_max
```

Maximum phase current (peak value, or RMS*sqrt2)

5.14.2.4 J

```
float J
```

Rotational inertia in N·m·s²

5.14.2.5 lambda

```
float lambda
```

Magnet flux linkage measured V_pk_ph-n · s (phase-neutral peak voltage divided by electrical speed in rad/s)

5.14.2.6 Ld

```
float Ld
```

D-axis inductance in Henries

5.14.2.7 Lq

```
float Lq
```

Q-axis inductance in Henries

5.14.2.8 pp

```
int pp
```

Pole pairs (total number of poles divided by 2)

5.14.2.9 Rs

```
float Rs
```

Stator resistance in Ohms

5.14.2.10 speed_max_RPM

```
float speed_max_RPM
```

Maximum speed in RPM

5.14.2.11 torque_max

```
float torque_max
```

Maximum torque in N·m

5.14.2.12 vDC_max

```
float vDC_max
```

Maximum DC bus voltage in volts

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/MOTOR.h

5.15 pi_aw_struct Struct Reference

PI Controller with internal saturation, anti-windup, and feedforward.

```
#include <PergaMOD.h>
```

Data Fields

- `uint16_t enable`
- `float Ts`
- `float Kp`
- `float Ki`
- `float Kaw`
- `float e [2]`
- `float pi_consig`
- `float pi_fdb`
- `float pi_out_max`
- `float pi_out_min`
- `float pi_out_presat`
- `float pi_out_postsat`
- `float pi_out`
- `float pi_int [2]`
- `float pi_ffw [2]`
- `void(* calc)()`

5.15.1 Detailed Description

PI Controller with internal saturation, anti-windup, and feedforward.

5.15.2 Field Documentation

5.15.2.1 calc

```
void(* calc) ()
```

Pointer to the calculation function

5.15.2.2 e

```
float e[2]
```

Error at current and previous step

5.15.2.3 enable

```
uint16_t enable
```

Enable flag for the controller

5.15.2.4 Kaw

```
float Kaw
```

Anti-windup gain

5.15.2.5 Ki

float Ki

Integral gain

5.15.2.6 Kp

float Kp

Proportional gain

5.15.2.7 pi_consig

float pi_consig

Setpoint

5.15.2.8 pi_fdb

float pi_fdb

Feedback

5.15.2.9 pi_ffw

float pi_ffw[2]

Feedforward at current and previous step

5.15.2.10 pi_int

float pi_int[2]

Integrator Part

5.15.2.11 pi_out

float pi_out

Controller output

5.15.2.12 pi_out_max

float pi_out_max

Maximum output

5.15.2.13 pi_out_min

float pi_out_min

Minimum output

5.15.2.14 pi_out_postsat

float pi_out_postsat

Output after saturation

5.15.2.15 pi_out_presat

float pi_out_presat

Output before saturation

5.15.2.16 Ts

float Ts

Execution period

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/PergaMOD.h

5.16 pi_struct Struct Reference

PI Controller with external saturation and feedforward.

```
#include <PergaMOD.h>
```

Data Fields

- uint16_t enable
- float Ts
- float Kp
- float Ki
- float K0
- float K1
- float e [2]
- float pi_consig
- float pi_fdb
- float pi_out_max
- float pi_out_min
- float pi_out
- float pi_ffw [2]
- void(* init)()
- void(* calc)()

5.16.1 Detailed Description

PI Controller with external saturation and feedforward.

5.16.2 Field Documentation

5.16.2.1 calc

```
void(* calc) ()
```

Pointer to the calculation function

5.16.2.2 e

```
float e[2]
```

Error at current and previous step

5.16.2.3 enable

```
uint16_t enable
```

Enable flag for the controller

5.16.2.4 init

```
void(* init) ()
```

Pointer to the initialization function

5.16.2.5 K0

```
float K0
```

$$K0 = Kp + (Ts*Ki)/2$$

5.16.2.6 K1

```
float K1
```

$$K0 = -Kp + (Ts*Ki)/2$$

5.16.2.7 Ki

float Ki

Integral gain

5.16.2.8 Kp

float Kp

Proportional gain

5.16.2.9 pi_consig

float pi_consig

Setpoint

5.16.2.10 pi_fdb

float pi_fdb

Feedback

5.16.2.11 pi_ffw

float pi_ffw[2]

Feedforward at current and previous step

5.16.2.12 pi_out

float pi_out

Controller output

5.16.2.13 pi_out_max

float pi_out_max

Maximum output

5.16.2.14 pi_out_min

float pi_out_min

Minimum output

5.16.2.15 Ts

float Ts

Execution period

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/PergaMOD.h

5.17 rampa_dual_struct Struct Reference

Dual-ramp generator.

```
#include <PergaMOD.h>
```

Data Fields

- float [in](#)
- float [out](#)
- float [Incr](#)
- float [Decr](#)
- uint8_t [enable](#)
- void(* [calc](#))()

5.17.1 Detailed Description

Dual-ramp generator.

5.17.2 Field Documentation

5.17.2.1 calc

```
void(* calc) ()
```

Pointer to the calculation function

5.17.2.2 Decr

```
float Decr
```

Decrement

5.17.2.3 enable

uint8_t enable

Enable flag

5.17.2.4 in

float in

Input signal

5.17.2.5 Incr

float Incr

Increment

5.17.2.6 out

float out

Output signal

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/PergaMOD.h

5.18 rampa_struct Struct Reference

Single-ramp generator.

```
#include <PergaMOD.h>
```

Data Fields

- float [in](#)
- float [out](#)
- float [Incr](#)
- uint8_t [enable](#)
- void(*) [calc](#) ()

5.18.1 Detailed Description

Single-ramp generator.

5.18.2 Field Documentation

5.18.2.1 calc

```
void(* calc) ()
```

Pointer to the calculation function

5.18.2.2 enable

```
uint8_t enable
```

Enable flag

5.18.2.3 in

```
float in
```

Input signal

5.18.2.4 Incr

```
float Incr
```

Increment

5.18.2.5 out

```
float out
```

Output signal

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/PergaMOD.h

5.19 RMS_struct Struct Reference

Root Mean Square (RMS) calculation.

```
#include <PergaMOD.h>
```

Data Fields

- float `T_exec`
- float `Measure`
- float `Sq_Sum`
- float `Out_RMS`
- float `Freq`
- float `Angle`
- float `Angle_ant`

5.19.1 Detailed Description

Root Mean Square (RMS) calculation.

5.19.2 Field Documentation

5.19.2.1 Angle

float Angle

Angle

5.19.2.2 Angle_ant

float Angle_ant

Previous angle

5.19.2.3 Freq

float Freq

Output frequency of the PLL

5.19.2.4 Measure

float Measure

Signal to be RMSed

5.19.2.5 Out_RMS

float Out_RMS

RMSed signal

5.19.2.6 Sq_Sum

float Sq_Sum

Sum of squares

5.19.2.7 T_exec

float T_exec

Execution frequency of the function

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/PergaMOD.h

5.20 rot_struct Struct Reference

Rotates the DQ axis in the opposite direction (clockwise).

```
#include <PergaMOD.h>
```

Data Fields

- float **D**
- float **Q**
- float **sinFi**
- float **cosFi**
- float **d**
- float **q**
- void(* **calc**)()

5.20.1 Detailed Description

Rotates the DQ axis in the opposite direction (clockwise).

5.20.2 Field Documentation

5.20.2.1 calc

```
void(* calc) ()
```

Pointer to the calculation function

5.20.2.2 cosFi

```
float cosFi
```

Cosine of the angle of rotation

5.20.2.3 D

```
float D
```

D-axis input

5.20.2.4 d

```
float d
```

Rotated D-axis

5.20.2.5 Q

```
float Q
```

Q-axis input

5.20.2.6 q

```
float q
```

Rotated Q-axis

5.20.2.7 sinFi

```
float sinFi
```

Sine of the angle of rotation

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/[PergaMOD.h](#)

5.21 step_struct Struct Reference

Step function generator.

```
#include <PergaMOD.h>
```

Data Fields

- float `fs`
- float `In`
- float `Out`
- float `Step`
- float `t_step`
- uint32_t `Pulses`
- uint32_t `Counter`
- uint16_t `enable`
- void(* `calc`)()

5.21.1 Detailed Description

Step function generator.

5.21.2 Field Documentation

5.21.2.1 calc

```
void(* calc) ()
```

Pointer to the calculation function

5.21.2.2 Counter

```
uint32_t Counter
```

Counter for pulses

5.21.2.3 enable

```
uint16_t enable
```

Enable flag

5.21.2.4 fs

```
float fs
```

Function execution frequency

5.21.2.5 In

```
float In
```

Input variable

5.21.2.6 Out

`float Out`

Output variable (with step when needed)

5.21.2.7 Pulses

`uint32_t Pulses`

Pulse counter for seconds

5.21.2.8 Step

`float Step`

Step amplitude

5.21.2.9 t_step

`float t_step`

Step duration in seconds

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/PergaMOD.h

5.22 svpwm_struct Struct Reference

Space Vector Pulse Width Modulation (SVPWM) implementation.

```
#include <PergaMOD.h>
```

Data Fields

- `float alpha`
- `float beta`
- `float Da`
- `float Db`
- `float Dc`
- `void(* calc)()`

5.22.1 Detailed Description

Space Vector Pulse Width Modulation (SVPWM) implementation.

5.22.2 Field Documentation

5.22.2.1 alpha

```
float alpha
```

Input in per-unit for alpha phase (0deg)

5.22.2.2 beta

```
float beta
```

Input in per-unit for beta phase (90deg)

5.22.2.3 calc

```
void(* calc) ()
```

Pointer to the calculation function

5.22.2.4 Da

```
float Da
```

Output for phase A (0-1)

5.22.2.5 Db

```
float Db
```

Output for phase B (0-1)

5.22.2.6 Dc

```
float Dc
```

Output for phase C (0-1)

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

- C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/[PergaMOD.h](#)

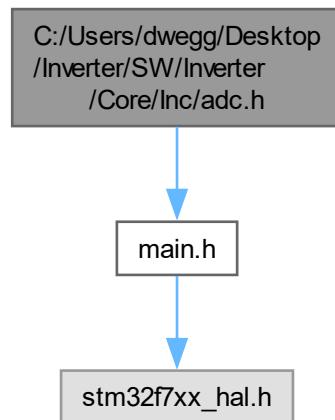
Chapter 6

File Documentation

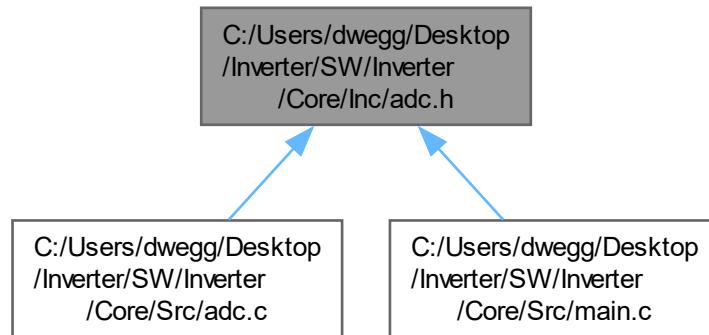
6.1 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/adc.h File Reference

This file contains all the function prototypes for the [adc.c](#) file.

```
#include "main.h"  
Include dependency graph for adc.h:
```



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



Functions

- void [MX_ADC1_Init](#) (void)
- void [MX_ADC2_Init](#) (void)
- void [MX_ADC3_Init](#) (void)

Variables

- ADC_HandleTypeDef [hadc1](#)
- ADC_HandleTypeDef [hadc2](#)
- ADC_HandleTypeDef [hadc3](#)

6.1.1 Detailed Description

This file contains all the function prototypes for the [adc.c](#) file.

Attention

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6.1.2 Function Documentation

6.1.2.1 MX_ADC1_Init()

```
void MX_ADC1_Init (
    void )
```

Configure the global features of the ADC (Clock, Resolution, Data Alignment and number of conversion)

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time. Here is the call graph for this function:



Here is the caller graph for this function:



6.1.2.2 MX_ADC2_Init()

```
void MX_ADC2_Init (
    void )
```

Configure the global features of the ADC (Clock, Resolution, Data Alignment and number of conversion)

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time. Here is the call graph for this function:



Here is the caller graph for this function:



6.1.2.3 MX_ADC3_Init()

```
void MX_ADC3_Init (
    void  )
```

Configure the global features of the ADC (Clock, Resolution, Data Alignment and number of conversion)

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time. Here is the call graph for this function:



Here is the caller graph for this function:



6.1.3 Variable Documentation

6.1.3.1 hadc1

```
ADC_HandleTypeDef hadc1 [extern]
```

6.1.3.2 hadc2

```
ADC_HandleTypeDef hadc2 [extern]
```

6.1.3.3 hadc3

```
ADC_HandleTypeDef hadc3 [extern]
```

6.2 adc.h

[Go to the documentation of this file.](#)

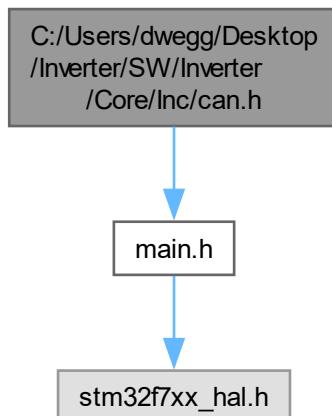
```
00001 /* USER CODE BEGIN Header */
00019 /* USER CODE END Header */
00020 /* Define to prevent recursive inclusion -----*/
00021 #ifndef __ADC_H__
00022 #define __ADC_H__
00023
00024 #ifdef __cplusplus
00025 extern "C" {
00026 #endif
00027
00028 /* Includes -----*/
00029 #include "main.h"
00030
00031 /* USER CODE BEGIN Includes */
00032
00033 /* USER CODE END Includes */
00034
00035 extern ADC_HandleTypeDef hadc1;
00036
00037 extern ADC_HandleTypeDef hadc2;
00038
00039 extern ADC_HandleTypeDef hadc3;
00040
00041 /* USER CODE BEGIN Private defines */
00042
00043 /* USER CODE END Private defines */
00044
00045 void MX_ADC1_Init(void);
00046 void MX_ADC2_Init(void);
00047 void MX_ADC3_Init(void);
00048
```

```
00049 /* USER CODE BEGIN Prototypes */  
00050  
00051 /* USER CODE END Prototypes */  
00052  
00053 #ifdef __cplusplus  
00054 }  
00055 #endif  
00056  
00057 #endif /* __ADC_H__ */  
00058
```

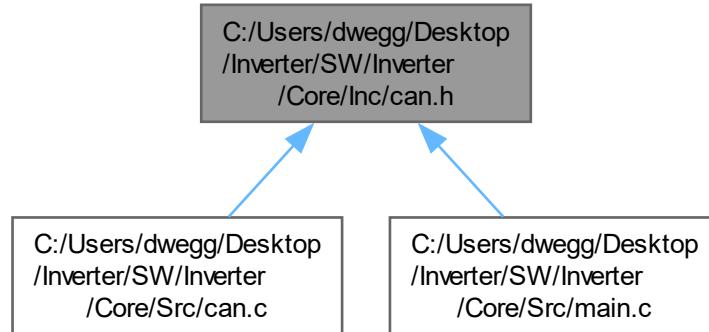
6.3 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/can.h File Reference

This file contains all the function prototypes for the [can.c](#) file.

```
#include "main.h"  
Include dependency graph for can.h:
```



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



Functions

- void [MX_CAN1_Init](#) (void)

Variables

- CAN_HandleTypeDef [hcan1](#)

6.3.1 Detailed Description

This file contains all the function prototypes for the [can.c](#) file.

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6.3.2 Function Documentation

6.3.2.1 MX_CAN1_Init()

```
void MX_CAN1_Init (
    void )
```

Here is the call graph for this function:



Here is the caller graph for this function:



6.3.3 Variable Documentation

6.3.3.1 hcan1

```
CAN_HandleTypeDef hcan1 [extern]
```

6.4 can.h

[Go to the documentation of this file.](#)

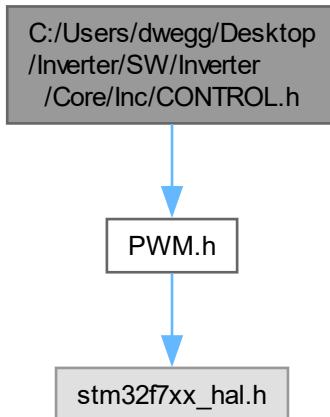
```
00001 /* USER CODE BEGIN Header */
00019 /* USER CODE END Header */
00020 /* Define to prevent recursive inclusion -----*/
00021 #ifndef __CAN_H__
00022 #define __CAN_H__
00023
00024 #ifdef __cplusplus
00025 extern "C" {
00026 #endif
00027
00028 /* Includes -----*/
00029 #include "main.h"
00030
00031 /* USER CODE BEGIN Includes */
00032
00033 /* USER CODE END Includes */
```

```
00034
00035 extern CAN_HandleTypeDef hcan1;
00036
00037 /* USER CODE BEGIN Private defines */
00038
00039 /* USER CODE END Private defines */
00040
00041 void MX_CAN1_Init(void);
00042
00043 /* USER CODE BEGIN Prototypes */
00044
00045 /* USER CODE END Prototypes */
00046
00047 #ifdef __cplusplus
00048 }
00049 #endif
00050
00051 #endif /* __CAN_H__ */
00052
```

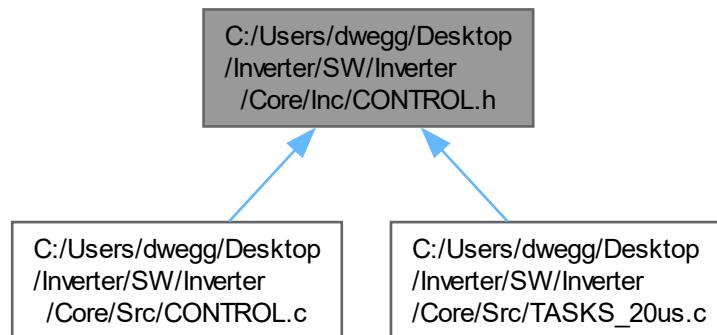
6.5 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/CONTROL.h File Reference

Header file for control logic.

```
#include "PWM.h"
Include dependency graph for CONTROL.h:
```



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



Functions

- void **calc_duties** (float vd, float vq, float vDC, float theta_e, volatile **Duties** *duties)
function.

6.5.1 Detailed Description

Header file for control logic.

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6.5.2 Function Documentation

6.5.2.1 calc_duties()

```

void calc_duties (
    float vd,
    float vq,
    float vDC,
    float theta_e,
    volatile Duties * duties )
  
```

function.

This function calculates the inverse Park transform (irot) and the duty cycles using SVPWM

Parameters

in	<i>vd</i>	Voltage in the d-axis.
in	<i>vq</i>	Voltage in the q-axis.
in	<i>vDC</i>	DC voltage.
in	<i>theta_e</i>	Electrical angle in radians (-pi..pi).
out	<i>duties</i>	Pointer to the duties structure.

This function calculates the inverse Park transform and the duty cycles using SVPWM

Parameters

in	<i>vd</i>	Voltage in the d-axis.
in	<i>vq</i>	Voltage in the q-axis.
in	<i>vDC</i>	DC voltage.
in	<i>theta_e</i>	Electrical angle in radians (-pi..pi).
out	<i>duties</i>	Pointer to the duties structure.

Here is the call graph for this function:



Here is the caller graph for this function:



6.6 CONTROL.h

[Go to the documentation of this file.](#)

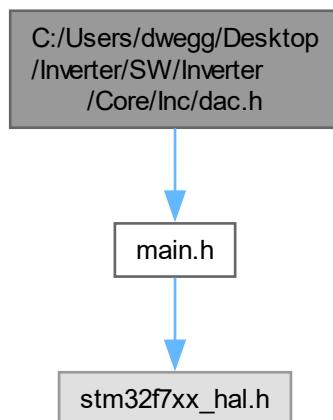
```

00001 /* USER CODE BEGIN Header */
00018 /* USER CODE END Header */
00019
00020 #ifndef CONTROL_H
00021 #define CONTROL_H
00022
00023 #include "PWM.h" // duties struct
00024
00025
00037 void calc_duties(float vd, float vq, float vDC, float theta_e, volatile Duties *duties);
00038
00039 #endif /* CONTROL_H */
  
```

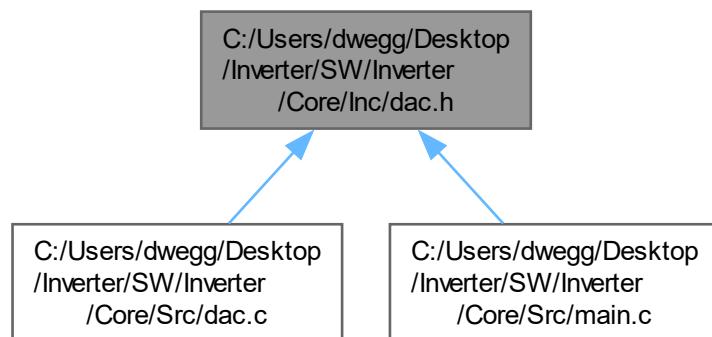
6.7 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/dac.h File Reference

This file contains all the function prototypes for the [dac.c](#) file.

```
#include "main.h"  
Include dependency graph for dac.h:
```



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



Functions

- void [MX_DAC_Init](#) (void)

Variables

- DAC_HandleTypeDef [hdac](#)

6.7.1 Detailed Description

This file contains all the function prototypes for the [dac.c](#) file.

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6.7.2 Function Documentation

6.7.2.1 MX_DAC_Init()

```
void MX_DAC_Init (
    void )
```

DAC Initialization

DAC channel OUT1 configHere is the call graph for this function:



Here is the caller graph for this function:



6.7.3 Variable Documentation

6.7.3.1 hdac

```
DAC_HandleTypeDef hdac [extern]
```

6.8 dac.h

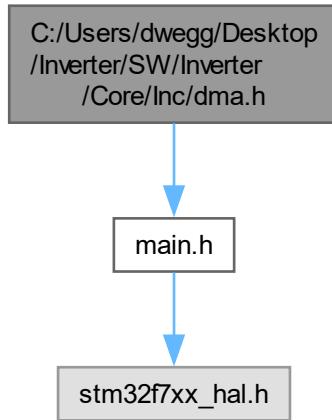
[Go to the documentation of this file.](#)

```
00001 /* USER CODE BEGIN Header */
00019 /* USER CODE END Header */
00020 /* Define to prevent recursive inclusion -----*/
00021 #ifndef __DAC_H__
00022 #define __DAC_H__
00023
00024 #ifdef __cplusplus
00025 extern "C" {
00026 #endif
00027
00028 /* Includes -----*/
00029 #include "main.h"
00030
00031 /* USER CODE BEGIN Includes */
00032
00033 /* USER CODE END Includes */
00034
00035 extern DAC_HandleTypeDef hdac;
00036
00037 /* USER CODE BEGIN Private defines */
00038
00039 /* USER CODE END Private defines */
00040
00041 void MX_DAC_Init(void);
00042
00043 /* USER CODE BEGIN Prototypes */
00044
00045 /* USER CODE END Prototypes */
00046
00047 #ifdef __cplusplus
00048 }
00049 #endif
00050
00051 #endif /* __DAC_H__ */
00052
```

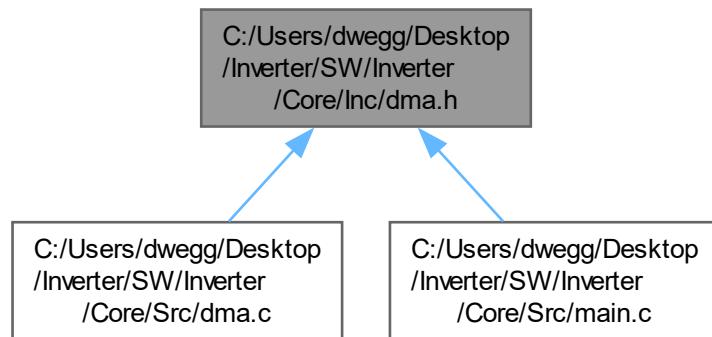
6.9 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/dma.h File Reference

This file contains all the function prototypes for the [dma.c](#) file.

```
#include "main.h"  
Include dependency graph for dma.h:
```



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



Functions

- void [MX_DMA_Init](#) (void)

6.9.1 Detailed Description

This file contains all the function prototypes for the [dma.c](#) file.

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6.9.2 Function Documentation

6.9.2.1 MX_DMA_Init()

```
void MX_DMA_Init (
    void )
```

Enable DMA controller clock Here is the caller graph for this function:



6.10 dma.h

[Go to the documentation of this file.](#)

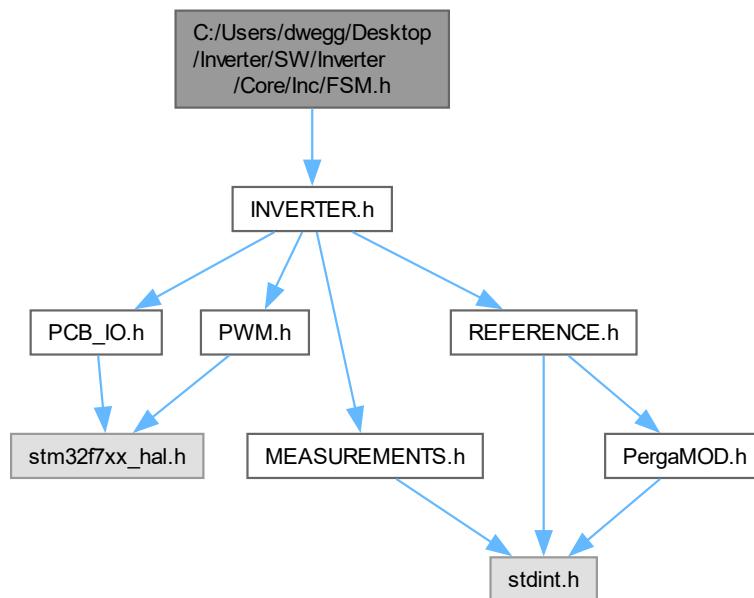
```
00001 /* USER CODE BEGIN Header */
00019 /* USER CODE END Header */
00020 /* Define to prevent recursive inclusion -----*/
00021 #ifndef __DMA_H__
00022 #define __DMA_H__
00023
00024 #ifdef __cplusplus
00025 extern "C" {
00026 #endif
00027
00028 /* Includes -----*/
00029 #include "main.h"
00030
00031 /* DMA memory to memory transfer handles -----*/
00032
00033 /* USER CODE BEGIN Includes */
00034
00035 /* USER CODE END Includes */
00036
00037 /* USER CODE BEGIN Private defines */
00038
00039 /* USER CODE END Private defines */
00040
00041 void MX_DMA_Init(void);
00042
00043 /* USER CODE BEGIN Prototypes */
00044
00045 /* USER CODE END Prototypes */
00046
00047 #ifdef __cplusplus
00048 }
00049 #endif
00050
00051 #endif /* __DMA_H__ */
00052
```

6.11 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/FSM.h File Reference

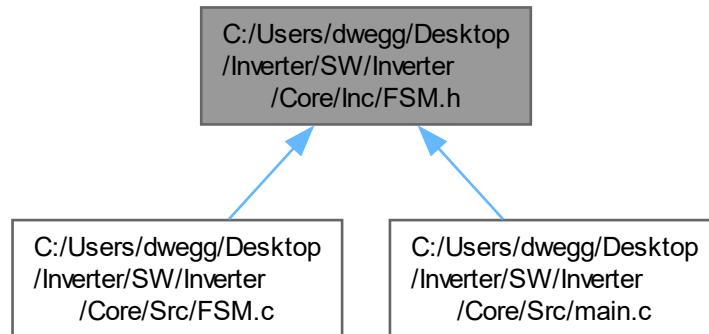
Header for the inverter Finite State Machine.

```
#include "INVERTER.h"
```

Include dependency graph for FSM.h:



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



Functions

- void `eval_inv_FSM` (volatile `InverterStruct` *`inv`)
Run the Finite State Machine (FSM) for inverter operation control.

6.11.1 Detailed Description

Header for the inverter Finite State Machine.

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6.11.2 Function Documentation

6.11.2.1 `eval_inv_FSM()`

```
void eval_inv_FSM (
    volatile InverterStruct * inv )
```

Run the Finite State Machine (FSM) for inverter operation control.

Parameters

<code>inv</code>	Pointer to the inverter structure.
------------------	------------------------------------

Run the Finite State Machine (FSM) for inverter operation control.

This function executes the finite state machine to control the inverter based on its current state.

Parameters

<code>inv</code>	Pointer to the inverter structure.
------------------	------------------------------------

Here is the caller graph for this function:



6.12 FSM.h

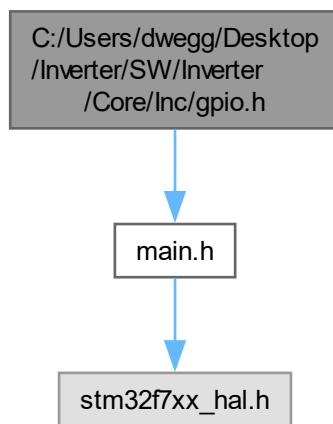
[Go to the documentation of this file.](#)

```
00001 /* USER CODE BEGIN Header */
00018 /* USER CODE END Header */
00019
00020 #ifndef FSM_H
00021 #define FSM_H
00022 #include "INVERTER.h" // inverter struct
00023
00024
00030 void eval_inv_FSM(volatile InverterStruct *inv);
00031
00032 #endif /* FSM_H */
```

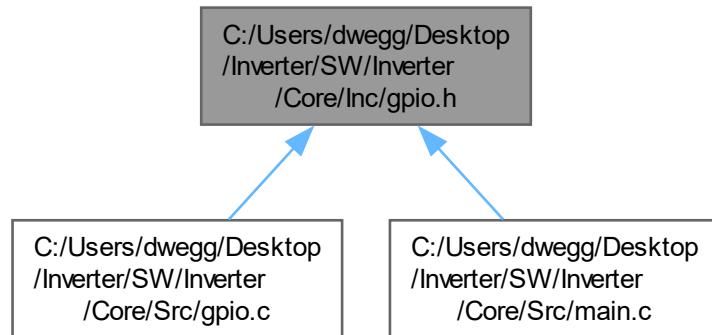
6.13 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/gpio.h File Reference

This file contains all the function prototypes for the [gpio.c](#) file.

```
#include "main.h"
Include dependency graph for gpio.h:
```



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



Functions

- void [MX_GPIO_Init](#) (void)

6.13.1 Detailed Description

This file contains all the function prototypes for the [gpio.c](#) file.

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6.13.2 Function Documentation

6.13.2.1 MX_GPIO_Init()

```
void MX_GPIO_Init (
    void )
```

Configure pins as [Analog](#) Input Output EVENT_OUT EXTI PA9 -----> USB_OTG_FS_VBUS PA10 -----> USB_<_OTG_FS_ID PA11 -----> USB_OTG_FS_DM PA12 -----> USB_OTG_FS_DP Here is the caller graph for this function:



6.14 gpio.h

[Go to the documentation of this file.](#)

```

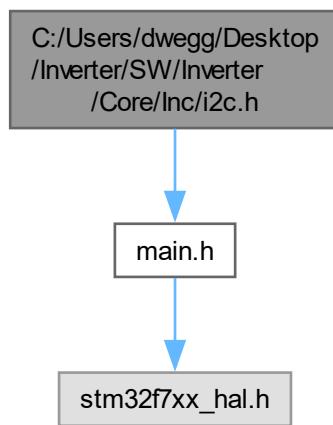
00001 /* USER CODE BEGIN Header */
00019 /* USER CODE END Header */
00020 /* Define to prevent recursive inclusion -----*/
00021 #ifndef __GPIO_H__
00022 #define __GPIO_H__
00023
00024 #ifdef __cplusplus
00025 extern "C" {
00026 #endif
00027
00028 /* Includes -----*/
00029 #include "main.h"
00030
00031 /* USER CODE BEGIN Includes */
00032
00033 /* USER CODE END Includes */
00034
00035 /* USER CODE BEGIN Private defines */
00036
00037 /* USER CODE END Private defines */
00038
00039 void MX_GPIO_Init(void);
00040
00041 /* USER CODE BEGIN Prototypes */
00042
00043 /* USER CODE END Prototypes */
00044
00045 #ifdef __cplusplus
00046 }
00047 #endif
00048 #endif /*__ GPIO_H__ */
00049

```

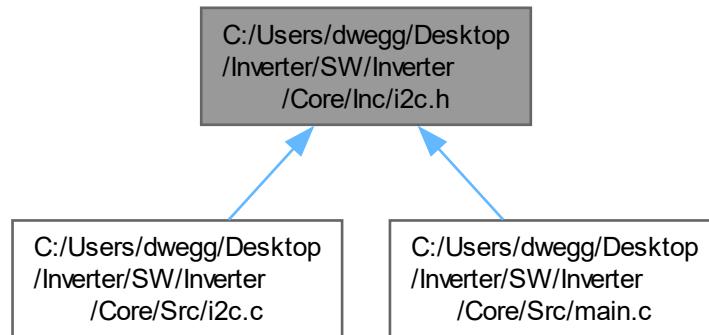
6.15 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/i2c.h File Reference

This file contains all the function prototypes for the [i2c.c](#) file.

```
#include "main.h"
Include dependency graph for i2c.h:
```



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



Functions

- void [MX_I2C1_Init](#) (void)

Variables

- I2C_HandleTypeDef [hi2c1](#)

6.15.1 Detailed Description

This file contains all the function prototypes for the [i2c.c](#) file.

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6.15.2 Function Documentation

6.15.2.1 MX_I2C1_Init()

```
void MX_I2C1_Init (
    void )
```

Configure Analogue filter

Configure Digital filterHere is the call graph for this function:



Here is the caller graph for this function:



6.15.3 Variable Documentation

6.15.3.1 hi2c1

```
I2C_HandleTypeDef hi2c1 [extern]
```

6.16 i2c.h

[Go to the documentation of this file.](#)

```
00001 /* USER CODE BEGIN Header */
00019 /* USER CODE END Header */
00020 /* Define to prevent recursive inclusion -----*/
00021 #ifndef __I2C_H__
00022 #define __I2C_H__
00023
00024 #ifdef __cplusplus
00025 extern "C" {
00026 #endif
00027
00028 /* Includes -----*/
00029 #include "main.h"
00030
```

```

00031 /* USER CODE BEGIN Includes */
00032
00033 /* USER CODE END Includes */
00034
00035 extern I2C_HandleTypeDef hi2c1;
00036
00037 /* USER CODE BEGIN Private defines */
00038
00039 /* USER CODE END Private defines */
00040
00041 void MX_I2C1_Init(void);
00042
00043 /* USER CODE BEGIN Prototypes */
00044
00045 /* USER CODE END Prototypes */
00046
00047 #ifdef __cplusplus
00048 }
00049 #endif
00050
00051 #endif /* __I2C_H__ */
00052

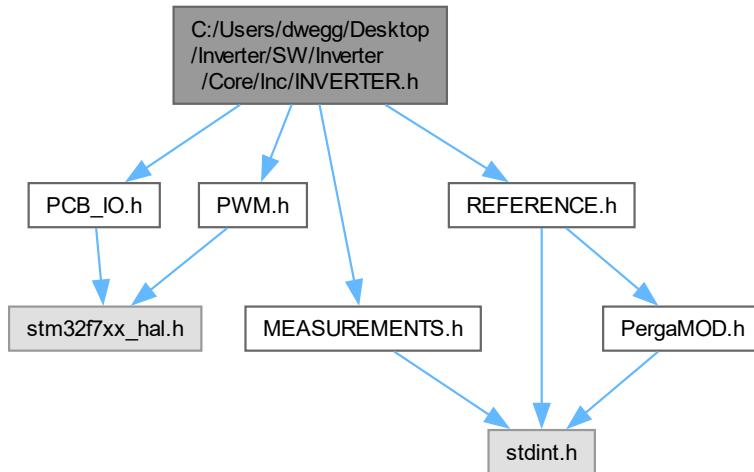
```

6.17 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/INVERTER.h File Reference

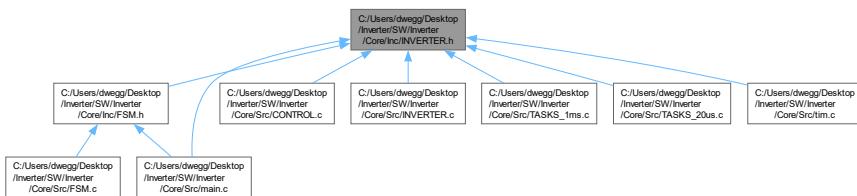
Header file for the inverter struct and extern variables.

```
#include "PCB_IO.h"
#include "MEASUREMENTS.h"
#include "REFERENCE.h"
#include "PWM.h"
```

Include dependency graph for INVERTER.h:



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



Data Structures

- struct `InverterStruct`
Inverter structure.

Macros

- `#define TS 0.00002`
- `#define DT 0.00000015`

Enumerations

- enum `InverterState` { `INV_STATE_IDLE` , `INV_STATE_STARTUP` , `INV_STATE_RUNNING` , `INV_STATE_FAULT` }

Enumeration of inverter operation states.

Functions

- void `initialize_inverter` (volatile `InverterStruct` *inv, `LED` *led, `GPIO_TypeDef` *enable_port, `uint16_t` enable_pin, `TIM_HandleTypeDef` *htim, `ADC_HandleTypeDef` *hadc)
Initialize the inverter.

Variables

- volatile `InverterStruct` `inverter_left`
Left inverter structure.
- volatile `InverterStruct` `inverter_right`
Right inverter structure.

6.17.1 Detailed Description

Header file for the inverter struct and extern variables.

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6.17.2 Macro Definition Documentation

6.17.2.1 DT

```
#define DT 0.00000015
```

Dead time in seconds (150 ns), time in which both top and bottom transistors are open

6.17.2.2 TS

```
#define TS 0.00002
```

Switching time in seconds (20 us), inverse of the switching frequency of 50 kHz

6.17.3 Enumeration Type Documentation

6.17.3.1 InverterState

```
enum InverterState
```

Enumeration of inverter operation states.

Enumerator

INV_STATE_IDLE	Inverter idle state
INV_STATE_STARTUP	Inverter startup state
INV_STATE_RUNNING	Inverter running state
INV_STATE_FAULT	Inverter fault state

6.17.4 Function Documentation

6.17.4.1 initialize_inverter()

```
void initialize_inverter (
    volatile InverterStruct * inv,
    LED * led,
    GPIO_TypeDef * enable_port,
    uint16_t enable_pin,
    TIM_HandleTypeDef * htim,
    ADC_HandleTypeDef * hadc )
```

Initialize the inverter.

This function initializes the inverter structure with the specified [LED](#), GPIO port, and pin.

Parameters

out	inv	Pointer to the inverter structure.
-----	-----	------------------------------------

Parameters

in	<i>led</i>	Pointer to the LED structure.
in	<i>enable_port</i>	Pointer to the GPIO port for enabling/disabling the inverter.
in	<i>enable_pin</i>	Pin number for enabling/disabling the inverter.
in	<i>htim</i>	Timer peripheral for the PWM output.
in	<i>hadc</i>	ADC peripheral for the current phase current and DC voltage sensing.

Here is the caller graph for this function:



6.17.5 Variable Documentation

6.17.5.1 inverter_left

```
volatile InverterStruct inverter_left [extern]
```

Left inverter structure.

External declaration of the left inverter structure

External declaration of the left inverter structure.

6.17.5.2 inverter_right

```
volatile InverterStruct inverter_right [extern]
```

Right inverter structure.

External declaration of the right inverter structure

External declaration of the right inverter structure.

6.18 INVERTER.h

[Go to the documentation of this file.](#)

```

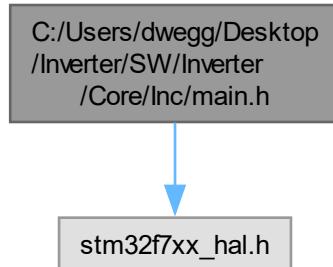
00001 /* USER CODE BEGIN Header */
00018 /* USER CODE END Header */
00019
00020 #ifndef INVERTER_H
00021 #define INVERTER_H
00022
00023 #include "PCB_IO.h" // peripheral types
00024 #include "MEASUREMENTS.h" // needs structs
00025 #include "REFERENCE.h" // reference struct
00026 #include "PWM.h" // duties struct
00027
00028
00032 typedef enum {
00033     INV_STATE_IDLE,
00034     INV_STATE_STARTUP,
00035     INV_STATE_RUNNING,
00036     INV_STATE_FAULT
00037 } InverterState;
00038
00039 #define TS 0.00002
00040 #define DT 0.00000015
00045 typedef struct {
00046     LED *led;
00047     GPIO_TypeDef *enable_port;
00048     uint16_t enable_pin;
00049     TIM_HandleTypeDef *htim;
00050     ADC_HandleTypeDef *hadc;
00051     InverterState state;
00052     Analog analog;
00053     Encoder encoder;
00054     Feedback feedback;
00055     Duties duties;
00056     int8_t direction;
00057     float temp_inverter;
00058     float temp_motor;
00059 } InverterStruct;
00060
00061 extern volatile InverterStruct inverter_left;
00062 extern volatile InverterStruct inverter_right;
00076 void initialize_inverter(volatile InverterStruct *inv, LED *led, GPIO_TypeDef *enable_port, uint16_t
    enable_pin, TIM_HandleTypeDef *htim, ADC_HandleTypeDef *hadc);
00077
00078
00079 #endif /* INVERTER_H */

```

6.19 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/main.h File Reference

: Header for [main.c](#) file. This file contains the common defines of the application.

```
#include "stm32f7xx_hal.h"
Include dependency graph for main.h:
```



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



Macros

- #define TS 0.00002
- #define DT 0.00000015
- #define Tinv_L_Pin GPIO_PIN_0
- #define Tinv_L_GPIO_Port GPIOC
- #define Tinv_R_Pin GPIO_PIN_1
- #define Tinv_R_GPIO_Port GPIOC
- #define Tmot_L_Pin GPIO_PIN_2
- #define Tmot_L_GPIO_Port GPIOC
- #define Tmot_R_Pin GPIO_PIN_3
- #define Tmot_R_GPIO_Port GPIOC
- #define ia_L_Pin GPIO_PIN_0
- #define ia_L_GPIO_Port GPIOA
- #define ib_L_Pin GPIO_PIN_1
- #define ib_L_GPIO_Port GPIOA
- #define ic_L_Pin GPIO_PIN_2
- #define ic_L_GPIO_Port GPIOA
- #define VDC_L_Pin GPIO_PIN_3
- #define VDC_L_GPIO_Port GPIOA
- #define DAC_Pin GPIO_PIN_4
- #define DAC_GPIO_Port GPIOA
- #define PWM1_R_Pin GPIO_PIN_5
- #define PWM1_R_GPIO_Port GPIOA
- #define ia_R_Pin GPIO_PIN_6
- #define ia_R_GPIO_Port GPIOA

- #define ib_R_Pin GPIO_PIN_7
- #define ib_R_GPIO_Port GPIOA
- #define SC_det_Pin GPIO_PIN_4
- #define SC_det_GPIO_Port GPIOC
- #define ic_R_Pin GPIO_PIN_0
- #define ic_R_GPIO_Port GPIOB
- #define VDC_R_Pin GPIO_PIN_1
- #define VDC_R_GPIO_Port GPIOB
- #define ENABLE_R_Pin GPIO_PIN_2
- #define ENABLE_R_GPIO_Port GPIOB
- #define ENABLE_L_Pin GPIO_PIN_7
- #define ENABLE_L_GPIO_Port GPIOE
- #define PWM1_L_Pin GPIO_PIN_8
- #define PWM1_L_GPIO_Port GPIOE
- #define PWM2_L_Pin GPIO_PIN_9
- #define PWM2_L_GPIO_Port GPIOE
- #define PWM3_L_Pin GPIO_PIN_10
- #define PWM3_L_GPIO_Port GPIOE
- #define PWM4_L_Pin GPIO_PIN_11
- #define PWM4_L_GPIO_Port GPIOE
- #define PWM5_L_Pin GPIO_PIN_12
- #define PWM5_L_GPIO_Port GPIOE
- #define PWM6_L_Pin GPIO_PIN_13
- #define PWM6_L_GPIO_Port GPIOE
- #define WRN_L_Pin GPIO_PIN_14
- #define WRN_L_GPIO_Port GPIOE
- #define WRN_R_Pin GPIO_PIN_15
- #define WRN_R_GPIO_Port GPIOE
- #define B_R_Pin GPIO_PIN_10
- #define B_R_GPIO_Port GPIOB
- #define Z_R_Pin GPIO_PIN_11
- #define Z_R_GPIO_Port GPIOB
- #define PWM3_R_Pin GPIO_PIN_14
- #define PWM3_R_GPIO_Port GPIOB
- #define PWM5_R_Pin GPIO_PIN_15
- #define PWM5_R_GPIO_Port GPIOB
- #define A_L_Pin GPIO_PIN_12
- #define A_L_GPIO_Port GPIOD
- #define B_L_Pin GPIO_PIN_14
- #define B_L_GPIO_Port GPIOD
- #define Z_L_Pin GPIO_PIN_15
- #define Z_L_GPIO_Port GPIOD
- #define PWM2_R_Pin GPIO_PIN_6
- #define PWM2_R_GPIO_Port GPIOC
- #define PWM4_R_Pin GPIO_PIN_7
- #define PWM4_R_GPIO_Port GPIOC
- #define PWM6_R_Pin GPIO_PIN_8
- #define PWM6_R_GPIO_Port GPIOC
- #define TRIP_R_Pin GPIO_PIN_9
- #define TRIP_R_GPIO_Port GPIOC
- #define TRIP_L_Pin GPIO_PIN_8
- #define TRIP_L_GPIO_Port GPIOA
- #define A_R_Pin GPIO_PIN_15
- #define A_R_GPIO_Port GPIOA
- #define DIR_Pin GPIO_PIN_3

- #define DIR_GPIO_Port GPIOD
- #define LED_LEFT_Pin GPIO_PIN_4
- #define LED_LEFT_GPIO_Port GPIOD
- #define LED_RIGHT_Pin GPIO_PIN_5
- #define LED_RIGHT_GPIO_Port GPIOD
- #define LED_ERR_Pin GPIO_PIN_6
- #define LED_ERR_GPIO_Port GPIOD

Functions

- void Error_Handler (void)
This function is executed in case of error occurrence.

6.19.1 Detailed Description

: Header for [main.c](#) file. This file contains the common defines of the application.

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6.19.2 Macro Definition Documentation

6.19.2.1 A_L_GPIO_Port

```
#define A_L_GPIO_Port GPIOD
```

6.19.2.2 A_L_Pin

```
#define A_L_Pin GPIO_PIN_12
```

6.19.2.3 A_R_GPIO_Port

```
#define A_R_GPIO_Port GPIOA
```

6.19.2.4 A_R_Pin

```
#define A_R_Pin GPIO_PIN_15
```

6.19.2.5 B_L_GPIO_Port

```
#define B_L_GPIO_Port GPIOD
```

6.19.2.6 B_L_Pin

```
#define B_L_Pin GPIO_PIN_14
```

6.19.2.7 B_R_GPIO_Port

```
#define B_R_GPIO_Port GPIOB
```

6.19.2.8 B_R_Pin

```
#define B_R_Pin GPIO_PIN_10
```

6.19.2.9 DAC_GPIO_Port

```
#define DAC_GPIO_Port GPIOA
```

6.19.2.10 DAC_Pin

```
#define DAC_Pin GPIO_PIN_4
```

6.19.2.11 DIR_GPIO_Port

```
#define DIR_GPIO_Port GPIOD
```

6.19.2.12 DIR_Pin

```
#define DIR_Pin GPIO_PIN_3
```

6.19.2.13 DT

```
#define DT 0.00000015
```

6.19.2.14 ENABLE_L_GPIO_Port

```
#define ENABLE_L_GPIO_Port GPIOE
```

6.19.2.15 ENABLE_L_Pin

```
#define ENABLE_L_Pin GPIO_PIN_7
```

6.19.2.16 ENABLE_R_GPIO_Port

```
#define ENABLE_R_GPIO_Port GPIOB
```

6.19.2.17 ENABLE_R_Pin

```
#define ENABLE_R_Pin GPIO_PIN_2
```

6.19.2.18 ia_L_GPIO_Port

```
#define ia_L_GPIO_Port GPIOA
```

6.19.2.19 ia_L_Pin

```
#define ia_L_Pin GPIO_PIN_0
```

6.19.2.20 ia_R_GPIO_Port

```
#define ia_R_GPIO_Port GPIOA
```

6.19.2.21 ia_R_Pin

```
#define ia_R_Pin GPIO_PIN_6
```

6.19.2.22 ib_L_GPIO_Port

```
#define ib_L_GPIO_Port GPIOA
```

6.19.2.23 ib_L_Pin

```
#define ib_L_Pin GPIO_PIN_1
```

6.19.2.24 ib_R_GPIO_Port

```
#define ib_R_GPIO_Port GPIOA
```

6.19.2.25 ib_R_Pin

```
#define ib_R_Pin GPIO_PIN_7
```

6.19.2.26 ic_L_GPIO_Port

```
#define ic_L_GPIO_Port GPIOA
```

6.19.2.27 ic_L_Pin

```
#define ic_L_Pin GPIO_PIN_2
```

6.19.2.28 ic_R_GPIO_Port

```
#define ic_R_GPIO_Port GPIOB
```

6.19.2.29 ic_R_Pin

```
#define ic_R_Pin GPIO_PIN_0
```

6.19.2.30 LED_ERR_GPIO_Port

```
#define LED_ERR_GPIO_Port GPIOD
```

6.19.2.31 LED_ERR_Pin

```
#define LED_ERR_Pin GPIO_PIN_6
```

6.19.2.32 LED_LEFT_GPIO_Port

```
#define LED_LEFT_GPIO_Port GPIOD
```

6.19.2.33 LED_LEFT_Pin

```
#define LED_LEFT_Pin GPIO_PIN_4
```

6.19.2.34 LED_RIGHT_GPIO_Port

```
#define LED_RIGHT_GPIO_Port GPIOD
```

6.19.2.35 LED_RIGHT_Pin

```
#define LED_RIGHT_Pin GPIO_PIN_5
```

6.19.2.36 PWM1_L_GPIO_Port

```
#define PWM1_L_GPIO_Port GPIOE
```

6.19.2.37 PWM1_L_Pin

```
#define PWM1_L_Pin GPIO_PIN_8
```

6.19.2.38 PWM1_R_GPIO_Port

```
#define PWM1_R_GPIO_Port GPIOA
```

6.19.2.39 PWM1_R_Pin

```
#define PWM1_R_Pin GPIO_PIN_5
```

6.19.2.40 PWM2_L_GPIO_Port

```
#define PWM2_L_GPIO_Port GPIOE
```

6.19.2.41 PWM2_L_Pin

```
#define PWM2_L_Pin GPIO_PIN_9
```

6.19.2.42 PWM2_R_GPIO_Port

```
#define PWM2_R_GPIO_Port GPIOC
```

6.19.2.43 PWM2_R_Pin

```
#define PWM2_R_Pin GPIO_PIN_6
```

6.19.2.44 PWM3_L_GPIO_Port

```
#define PWM3_L_GPIO_Port GPIOE
```

6.19.2.45 PWM3_L_Pin

```
#define PWM3_L_Pin GPIO_PIN_10
```

6.19.2.46 PWM3_R_GPIO_Port

```
#define PWM3_R_GPIO_Port GPIOB
```

6.19.2.47 PWM3_R_Pin

```
#define PWM3_R_Pin GPIO_PIN_14
```

6.19.2.48 PWM4_L_GPIO_Port

```
#define PWM4_L_GPIO_Port GPIOE
```

6.19.2.49 PWM4_L_Pin

```
#define PWM4_L_Pin GPIO_PIN_11
```

6.19.2.50 PWM4_R_GPIO_Port

```
#define PWM4_R_GPIO_Port GPIOC
```

6.19.2.51 PWM4_R_Pin

```
#define PWM4_R_Pin GPIO_PIN_7
```

6.19.2.52 PWM5_L_GPIO_Port

```
#define PWM5_L_GPIO_Port GPIOE
```

6.19.2.53 PWM5_L_Pin

```
#define PWM5_L_Pin GPIO_PIN_12
```

6.19.2.54 PWM5_R_GPIO_Port

```
#define PWM5_R_GPIO_Port GPIOB
```

6.19.2.55 PWM5_R_Pin

```
#define PWM5_R_Pin GPIO_PIN_15
```

6.19.2.56 PWM6_L_GPIO_Port

```
#define PWM6_L_GPIO_Port GPIOE
```

6.19.2.57 PWM6_L_Pin

```
#define PWM6_L_Pin GPIO_PIN_13
```

6.19.2.58 PWM6_R_GPIO_Port

```
#define PWM6_R_GPIO_Port GPIOC
```

6.19.2.59 PWM6_R_Pin

```
#define PWM6_R_Pin GPIO_PIN_8
```

6.19.2.60 SC_det_GPIO_Port

```
#define SC_det_GPIO_Port GPIOC
```

6.19.2.61 SC_det_Pin

```
#define SC_det_Pin GPIO_PIN_4
```

6.19.2.62 Tinv_L_GPIO_Port

```
#define Tinv_L_GPIO_Port GPIOC
```

6.19.2.63 Tinv_L_Pin

```
#define Tinv_L_Pin GPIO_PIN_0
```

6.19.2.64 Tinv_R_GPIO_Port

```
#define Tinv_R_GPIO_Port GPIOC
```

6.19.2.65 Tinv_R_Pin

```
#define Tinv_R_Pin GPIO_PIN_1
```

6.19.2.66 Tmot_L_GPIO_Port

```
#define Tmot_L_GPIO_Port GPIOC
```

6.19.2.67 Tmot_L_Pin

```
#define Tmot_L_Pin GPIO_PIN_2
```

6.19.2.68 Tmot_R_GPIO_Port

```
#define Tmot_R_GPIO_Port GPIOC
```

6.19.2.69 Tmot_R_Pin

```
#define Tmot_R_Pin GPIO_PIN_3
```

6.19.2.70 TRIP_L_GPIO_Port

```
#define TRIP_L_GPIO_Port GPIOA
```

6.19.2.71 TRIP_L_Pin

```
#define TRIP_L_Pin GPIO_PIN_8
```

6.19.2.72 TRIP_R_GPIO_Port

```
#define TRIP_R_GPIO_Port GPIOC
```

6.19.2.73 TRIP_R_Pin

```
#define TRIP_R_Pin GPIO_PIN_9
```

6.19.2.74 TS

```
#define TS 0.00002
```

6.19.2.75 VDC_L_GPIO_Port

```
#define VDC_L_GPIO_Port GPIOA
```

6.19.2.76 VDC_L_Pin

```
#define VDC_L_Pin GPIO_PIN_3
```

6.19.2.77 VDC_R_GPIO_Port

```
#define VDC_R_GPIO_Port GPIOB
```

6.19.2.78 VDC_R_Pin

```
#define VDC_R_Pin GPIO_PIN_1
```

6.19.2.79 WRN_L_GPIO_Port

```
#define WRN_L_GPIO_Port GPIOE
```

6.19.2.80 WRN_L_Pin

```
#define WRN_L_Pin GPIO_PIN_14
```

6.19.2.81 WRN_R_GPIO_Port

```
#define WRN_R_GPIO_Port GPIOE
```

6.19.2.82 WRN_R_Pin

```
#define WRN_R_Pin GPIO_PIN_15
```

6.19.2.83 Z_L_GPIO_Port

```
#define Z_L_GPIO_Port GPIOD
```

6.19.2.84 Z_L_Pin

```
#define Z_L_Pin GPIO_PIN_15
```

6.19.2.85 Z_R_GPIO_Port

```
#define Z_R_GPIO_Port GPIOB
```

6.19.2.86 Z_R_Pin

```
#define Z_R_Pin GPIO_PIN_11
```

6.19.3 Function Documentation

6.19.3.1 Error_Handler()

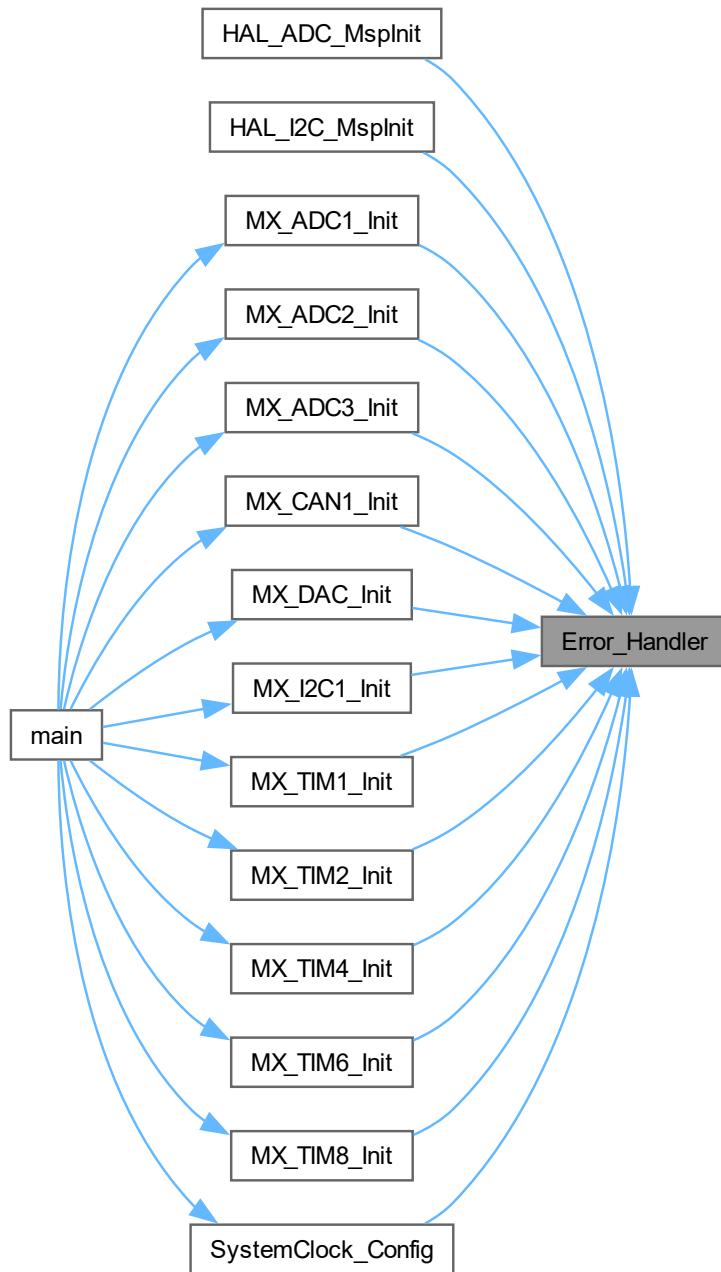
```
void Error_Handler (
    void )
```

This function is executed in case of error occurrence.

Return values

None	<input type="button" value=""/>
------	---------------------------------

Here is the caller graph for this function:



6.20 main.h

[Go to the documentation of this file.](#)

```
00001 /* USER CODE BEGIN Header */
00019 /* USER CODE END Header */
00020
00021 /* Define to prevent recursive inclusion -----*/
```

```
00022 #ifndef __MAIN_H
00023 #define __MAIN_H
00024
00025 #ifdef __cplusplus
00026 extern "C" {
00027 #endif
00028
00029 /* Includes -----*/
00030 #include "stm32f7xx_hal.h"
00031
00032 /* Private includes -----*/
00033 /* USER CODE BEGIN Includes */
00034
00035 /* USER CODE END Includes */
00036
00037 /* Exported types -----*/
00038 /* USER CODE BEGIN ET */
00039
00040 /* USER CODE END ET */
00041
00042 /* Exported constants -----*/
00043 /* USER CODE BEGIN EC */
00044
00045 /* USER CODE END EC */
00046
00047 /* Exported macro -----*/
00048 /* USER CODE BEGIN EM */
00049
00050 /* USER CODE END EM */
00051
00052 /* Exported functions prototypes -----*/
00053 void Error_Handler(void);
00054
00055 /* USER CODE BEGIN EFP */
00056
00057 /* USER CODE END EFP */
00058
00059 /* Private defines -----*/
00060 #define TS 0.00002
00061 #define DT 0.00000015
00062 #define Tinv_L_Pin GPIO_PIN_0
00063 #define Tinv_L_GPIO_Port GPIOC
00064 #define Tinv_R_Pin GPIO_PIN_1
00065 #define Tinv_R_GPIO_Port GPIOC
00066 #define Tmot_L_Pin GPIO_PIN_2
00067 #define Tmot_L_GPIO_Port GPIOC
00068 #define Tmot_R_Pin GPIO_PIN_3
00069 #define Tmot_R_GPIO_Port GPIOC
00070 #define ia_L_Pin GPIO_PIN_0
00071 #define ia_L_GPIO_Port GPIOA
00072 #define ib_L_Pin GPIO_PIN_1
00073 #define ib_L_GPIO_Port GPIOA
00074 #define ic_L_Pin GPIO_PIN_2
00075 #define ic_L_GPIO_Port GPIOA
00076 #define VDC_L_Pin GPIO_PIN_3
00077 #define VDC_L_GPIO_Port GPIOA
00078 #define DAC_Pin GPIO_PIN_4
00079 #define DAC_GPIO_Port GPIOA
00080 #define PWM1_R_Pin GPIO_PIN_5
00081 #define PWM1_R_GPIO_Port GPIOA
00082 #define ia_R_Pin GPIO_PIN_6
00083 #define ia_R_GPIO_Port GPIOA
00084 #define ib_R_Pin GPIO_PIN_7
00085 #define ib_R_GPIO_Port GPIOA
00086 #define SC_det_Pin GPIO_PIN_4
00087 #define SC_det_GPIO_Port GPIOC
00088 #define ic_R_Pin GPIO_PIN_0
00089 #define ic_R_GPIO_Port GPIOB
00090 #define VDC_R_Pin GPIO_PIN_1
00091 #define VDC_R_GPIO_Port GPIOB
00092 #define ENABLE_R_Pin GPIO_PIN_2
00093 #define ENABLE_R_GPIO_Port GPIOB
00094 #define ENABLE_L_Pin GPIO_PIN_7
00095 #define ENABLE_L_GPIO_Port GPIOE
00096 #define PWM1_L_Pin GPIO_PIN_8
00097 #define PWM1_L_GPIO_Port GPIOE
00098 #define PWM2_L_Pin GPIO_PIN_9
00099 #define PWM2_L_GPIO_Port GPIOE
00100 #define PWM3_L_Pin GPIO_PIN_10
00101 #define PWM3_L_GPIO_Port GPIOE
00102 #define PWM4_L_Pin GPIO_PIN_11
00103 #define PWM4_L_GPIO_Port GPIOE
00104 #define PWM5_L_Pin GPIO_PIN_12
00105 #define PWM5_L_GPIO_Port GPIOE
00106 #define PWM6_L_Pin GPIO_PIN_13
00107 #define PWM6_L_GPIO_Port GPIOE
00108 #define WRN_L_Pin GPIO_PIN_14
```

```

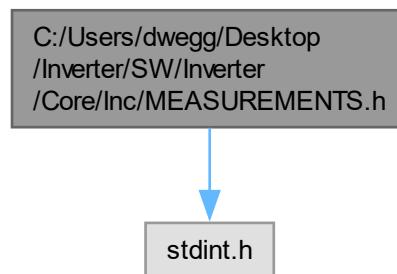
00109 #define WRN_L_GPIO_Port GPIOE
00110 #define WRN_R_Pin GPIO_PIN_15
00111 #define WRN_R_GPIO_Port GPIOE
00112 #define B_R_Pin GPIO_PIN_10
00113 #define B_R_GPIO_Port GPIOB
00114 #define Z_R_Pin GPIO_PIN_11
00115 #define Z_R_GPIO_Port GPIOB
00116 #define PWM3_R_Pin GPIO_PIN_14
00117 #define PWM3_R_GPIO_Port GPIOB
00118 #define PWM5_R_Pin GPIO_PIN_15
00119 #define PWM5_R_GPIO_Port GPIOB
00120 #define A_L_Pin GPIO_PIN_12
00121 #define A_L_GPIO_Port GPIOD
00122 #define B_L_Pin GPIO_PIN_14
00123 #define B_L_GPIO_Port GPIOD
00124 #define Z_L_Pin GPIO_PIN_15
00125 #define Z_L_GPIO_Port GPIOD
00126 #define PWM2_R_Pin GPIO_PIN_6
00127 #define PWM2_R_GPIO_Port GPIOC
00128 #define PWM4_R_Pin GPIO_PIN_7
00129 #define PWM4_R_GPIO_Port GPIOC
00130 #define PWM6_R_Pin GPIO_PIN_8
00131 #define PWM6_R_GPIO_Port GPIOC
00132 #define TRIP_R_Pin GPIO_PIN_9
00133 #define TRIP_R_GPIO_Port GPIOC
00134 #define TRIP_L_Pin GPIO_PIN_8
00135 #define TRIP_L_GPIO_Port GPIOA
00136 #define A_R_Pin GPIO_PIN_15
00137 #define A_R_GPIO_Port GPIOA
00138 #define DIR_Pin GPIO_PIN_3
00139 #define DIR_GPIO_Port GPIOD
00140 #define LED_LEFT_Pin GPIO_PIN_4
00141 #define LED_LEFT_GPIO_Port GPIOD
00142 #define LED_RIGHT_Pin GPIO_PIN_5
00143 #define LED_RIGHT_GPIO_Port GPIOD
00144 #define LED_ERR_Pin GPIO_PIN_6
00145 #define LED_ERR_GPIO_Port GPIOD
00146
00147 /* USER CODE BEGIN Private defines */
00148
00149 /* USER CODE END Private defines */
00150
00151 #ifdef __cplusplus
00152 }
00153 #endif
00154
00155 #endif /* __MAIN_H */

```

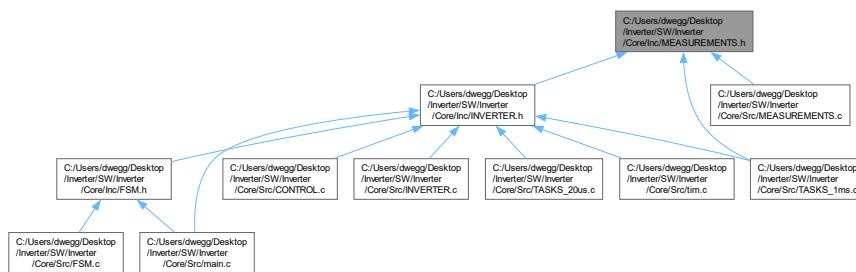
6.21 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/← MEASUREMENTS.h File Reference

Header file for handling measurements.

```
#include <stdint.h>
Include dependency graph for MEASUREMENTS.h:
```



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



Data Structures

- struct [Encoder](#)
Structure for encoder reading.
- struct [Analog](#)
Structure for ADC measurements in units.
- struct [Feedback](#)
Structure for feedback values.

Macros

- #define [CURRENT_SLOPE](#) 54.4217687f
- #define [CURRENT_OFFSET](#) 1.70068027211f
- #define [VOLTAGE_SLOPE](#) 263.435f
- #define [VOLTAGE_OFFSET](#) 0.02083f

Functions

- uint8_t [get_currents_voltage](#) (volatile uint32_t ADC_raw[], volatile [Analog](#) *analog)
Get electrical ADC measurements.
- float [get_linear](#) (uint32_t bits, float slope, float offset)
Convert ADC reading to physical measurement with linear response.
- void [get_idiq](#) (float ia, float ib, float ic, float theta_e, float *id_meas, float *iq_meas)
Computes d-q currents from current measurements and electrical angle.
- float [get_temperature](#) (uint32_t bits, const float tempLUT[])
Retrieves temperature from a lookup table based on ADC bits.

Variables

- const float [tempLUT_inverter](#) []
- const float [tempLUT_motor](#) []
- volatile uint32_t [rawADC_left](#) [4]
Raw ADC data for the left inverter.
- volatile uint32_t [rawADC_right](#) [4]
Raw ADC data for the right inverter.
- volatile uint32_t [rawADC_temp](#) [4]
Raw ADC data for the temperatures.

6.21.1 Detailed Description

Header file for handling measurements.

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6.21.2 Macro Definition Documentation

6.21.2.1 CURRENT_OFFSET

```
#define CURRENT_OFFSET 1.70068027211f  
[V] (10/(4.7+10))* 2.5 V
```

6.21.2.2 CURRENT_SLOPE

```
#define CURRENT_SLOPE 54.4217687f  
[A/V] (10/(4.7+10)) * ( 1 / (12.5 mV / A))
```

6.21.2.3 VOLTAGE_OFFSET

```
#define VOLTAGE_OFFSET 0.02083f  
[V] (100/(4700+100) * 5 V
```

6.21.2.4 VOLTAGE_SLOPE

```
#define VOLTAGE_SLOPE 263.435f  
[V/V] 1/(1/3 * 0.011388) V
```

6.21.3 Function Documentation

6.21.3.1 get_currents_voltage()

```
uint8_t get_currents_voltage (   
    volatile uint32_t ADC_raw[],  
    volatile Analog * analog )
```

Get electrical ADC measurements.

Parameters

in	<i>ADC_raw</i>	Pointer to the raw ADC values array.
out	<i>analog</i>	Pointer to the adc struct to store the results.

Return values

<i>OK</i>	0 if an error occurred, 1 if successful.
-----------	--

Parameters

in	<i>ADC_raw</i>	Pointer to the raw ADC values array.
out	<i>analog</i>	Pointer to the ADC struct to store the results.

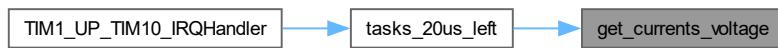
Return values

<i>OK</i>	0 if an error occurred, 1 if successful.
-----------	--

Here is the call graph for this function:



Here is the caller graph for this function:



6.21.3.2 `get_idiq()`

```

void get_idiq (
    float ia,
    float ib,
    float ic,
    float theta_e,
    float * id_meas,
    float * iq_meas )
  
```

Computes d-q currents from current measurements and electrical angle.

This function computes the d-q currents from phase currents (ABC), theta_e, and stores the results in the provided pointers.

Parameters

in	<i>ia</i>	Phase A current in A.
in	<i>ib</i>	Phase B current in A.
in	<i>ic</i>	Phase C current in A.
in	<i>theta_e</i>	Electrical rotor position in radians.
out	<i>id_meas</i>	Pointer to store the D-axis current.
out	<i>iq_meas</i>	Pointer to store the Q-axis current.

6.21.3.3 get_linear()

```
float get_linear (
    uint32_t bits,
    float slope,
    float offset )
```

Convert ADC reading to physical measurement with linear response.

Parameters

in	<i>bits</i>	The ADC reading.
in	<i>slope</i>	The slope (volts per unit).
in	<i>offset</i>	The offset (volts at zero).

Return values

<i>measurement</i>	The physical measurement.
--------------------	---------------------------

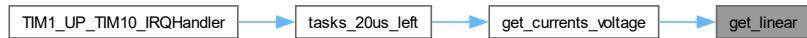
Parameters

in	<i>bits</i>	The ADC reading.
in	<i>slope</i>	The slope (units per volt).
in	<i>offset</i>	The offset (volts at zero).

Return values

<i>measurement</i>	The physical measurement.
--------------------	---------------------------

Here is the caller graph for this function:



6.21.3.4 `get_temperature()`

```
float get_temperature (
    uint32_t bits,
    const float tempLUT[ ] )
```

Retrieves temperature from a lookup table based on ADC bits.

This function retrieves temperature from a lookup table based on the ADC bits. The lookup table (LUT) must have a value for each possible ADC bit combination.

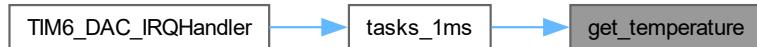
Parameters

in	<i>bits</i>	ADC reading converted to bits.
in	<i>tempLUT</i>	Lookup table containing temperature values.

Returns

Temperature corresponding to the provided ADC bits.

Here is the caller graph for this function:



6.21.4 Variable Documentation

6.21.4.1 `rawADC_left`

```
volatile uint32_t rawADC_left[4] [extern]
```

Raw ADC data for the left inverter.

External declaration of raw ADC data for the left inverter

External declaration of raw ADC data for the left inverter.

6.21.4.2 rawADC_right

```
volatile uint32_t rawADC_right[4] [extern]
```

Raw ADC data for the right inverter.

External declaration of raw ADC data for the right inverter

External declaration of raw ADC data for the right inverter.

6.21.4.3 rawADC_temp

```
volatile uint32_t rawADC_temp[4] [extern]
```

Raw ADC data for the temperatures.

External declaration of raw ADC data for the temperatures

External declaration of raw ADC data for the temperature readings.

6.21.4.4 tempLUT_inverter

```
const float tempLUT_inverter[] [extern]
```

6.21.4.5 tempLUT_motor

```
const float tempLUT_motor[] [extern]
```

6.22 MEASUREMENTS.h

[Go to the documentation of this file.](#)

```
00001 /* USER CODE BEGIN Header */
00017 /* USER CODE END Header */
00018
00019 /* Define current and voltage gains/offsets */
00020 #define CURRENT_SLOPE 54.4217687f
00021 #define CURRENT_OFFSET 1.70068027211f
00022 #define VOLTAGE_SLOPE 263.435f
00023 #define VOLTAGE_OFFSET 0.02083f
00025 #ifndef MEASUREMENTS_H
00026 #define MEASUREMENTS_H
00027
00028 #include <stdint.h>
00029
00030 extern const float tempLUT_inverter[];
00031 extern const float tempLUT_motor[];
00032
00033 extern volatile uint32_t rawADC_left[4];
00034 extern volatile uint32_t rawADC_right[4];
00035 extern volatile uint32_t rawADC_temp[4];
00041 typedef struct {
00042     uint16_t A;
00043     uint16_t B;
00044     uint16_t Z;
00045     float we;
00046     float theta_e;
00047     uint8_t direction_meas;
00048 } Encoder;
00049
00053 typedef struct {
```

```

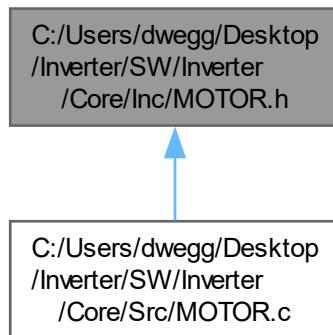
00054     float ia;
00055     float ib;
00056     float ic;
00057     float vDC;
00058 } Analog;
00059
00063 typedef struct {
00064     float id_meas;
00065     float iq_meas;
00066     float torque_calc;
00067     float speed_meas;
00068 } Feedback;
00069
00070 /* Define function prototypes */
00077 uint8_t get_currents_voltage(volatile uint32_t ADC_raw[], volatile Analog* analog);
00078
00086 float get_linear(uint32_t bits, float slope, float offset);
00087
00101 void get_idiq(float ia, float ib, float ic, float theta_e, float *id_meas, float *iq_meas);
00102
00103
00114 float get_temperature(uint32_t bits, const float tempLUT[]);
00115 #endif /* MEASUREMENTS_H */

```

6.23 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/MOTOR.h File Reference

Header file for motor parameters.

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



Data Structures

- struct **motorParameters**
Structure to hold motor parameters.

6.23.1 Detailed Description

Header file for motor parameters.

Attention

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6.24 MOTOR.h

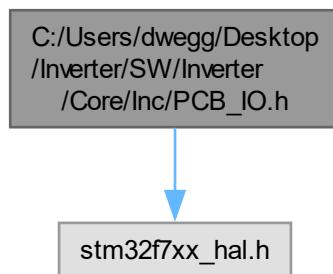
[Go to the documentation of this file.](#)

```
00001 /* USER CODE BEGIN Header */
00017 /* USER CODE END Header */
00018
00019 #ifndef MOTOR_H
00020 #define MOTOR_H
00021
00025 typedef struct {
00026     float Ld;
00027     float Lq;
00028     float Rs;
00029     float lambda;
00030     int pp;
00031     float J;
00032     float b;
00033     float torque_max;
00034     float dTorque_max;
00035     float speed_max_RPM;
00036     float iPhase_pk_max;
00037     float vDC_max;
00039 } motorParameters;
00040
00041 #endif /* MOTOR_H */
```

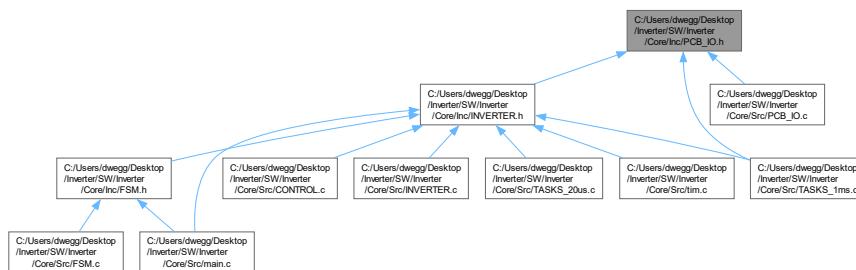
6.25 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/PCB_IO.h File Reference

Header file for handling GPIOs.

```
#include "stm32f7xx_hal.h"
Include dependency graph for PCB_IO.h:
```



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



Data Structures

- struct [LED](#)

LED structure.

Macros

- #define [SC_DET_STATE\(\)](#) (HAL_GPIO_ReadPin(SC_det_GPIO_Port, SC_det_Pin))
- #define [DIR_STATE\(\)](#) (HAL_GPIO_ReadPin(DIR_GPIO_Port, DIR_Pin))
- #define [WRN_STATE](#)(port, pin) (HAL_GPIO_ReadPin(port, pin))
- #define [ENABLE](#)(port, pin) do { HAL_GPIO_WritePin(port, pin, GPIO_PIN_SET); } while(0)
- #define [DISABLE](#)(port, pin) do { HAL_GPIO_WritePin(port, pin, GPIO_PIN_RESET); } while(0)

Enumerations

- enum [LEDMode](#) { [LED_MODE_BLINK_FAST](#) , [LED_MODE_BLINK_SLOW](#) , [LED_MODE_ON](#) , [LED_MODE_OFF](#) }

Functions

- void [handle_LED](#) ([LED](#) *led, uint32_t ms_counter)
LED handler function.
- void [handle_direction](#) (volatile int8_t *dir_left, volatile int8_t *dir_right)
Handles the direction of the motors.

Variables

- [LED led_left](#)
- [LED led_right](#)
- [LED ledError](#)

6.25.1 Detailed Description

Header file for handling GPIOs.

Attention

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6.25.2 Macro Definition Documentation

6.25.2.1 DIR_STATE

```
#define DIR_STATE( ) (HAL_GPIO_ReadPin(DIR_GPIO_Port, DIR_Pin))
```

6.25.2.2 DISABLE

```
#define DISABLE(
    port,
    pin ) do { HAL_GPIO_WritePin(port, pin, GPIO_PIN_RESET); } while(0)
```

6.25.2.3 ENABLE

```
#define ENABLE(
    port,
    pin ) do { HAL_GPIO_WritePin(port, pin, GPIO_PIN_SET); } while(0)
```

6.25.2.4 SC_DET_STATE

```
#define SC_DET_STATE( ) (HAL_GPIO_ReadPin(SC_det_GPIO_Port, SC_det_Pin))
```

6.25.2.5 WRN_STATE

```
#define WRN_STATE(
    port,
    pin ) (HAL_GPIO_ReadPin(port, pin))
```

6.25.3 Enumeration Type Documentation

6.25.3.1 LEDMode

```
enum LEDMode
```

Enumerator

LED_MODE_BLINK_FAST	Fast blink mode
LED_MODE_BLINK_SLOW	Slow blink mode
LED_MODE_ON	LED on mode
LED_MODE_OFF	LED off mode

6.25.4 Function Documentation

6.25.4.1 handle_direction()

```
void handle_direction (
    volatile int8_t * dir_left,
    volatile int8_t * dir_right )
```

Handles the direction of the motors.

This function reads the state of the DIR switch and updates the directions of both the left and right motors. If one motor is set to rotate clockwise (CW), the other one is set to rotate counterclockwise (CCW), and vice versa.

Parameters

<i>dir_left</i>	Pointer to the direction parameter in the left inverter structure.
<i>dir_right</i>	Pointer to the direction parameter in the right inverter structure.

Here is the caller graph for this function:



6.25.4.2 handle_LED()

```
void handle_LED (
    LED * led,
    uint32_t ms_counter )
```

LED handler function.

This function handles the LED blinking modes based on the LED mode and current millisecond counter.

Parameters

<i>led</i>	Pointer to the LED structure.
<i>ms_counter</i>	Millisecond counter for timing.

This function handles the LED blinking modes based on the LED mode and current millisecond counter.

Parameters

<i>led</i>	Pointer to the LED structure.
<i>ms_counter</i>	Current millisecond counter.

Here is the caller graph for this function:



6.25.5 Variable Documentation

6.25.5.1 led_left

```
LED led_left [extern]
```

6.25.5.2 led_right

```
LED led_right [extern]
```

6.25.5.3 ledError

```
LED ledError [extern]
```

6.26 PCB_IO.h

[Go to the documentation of this file.](#)

```

00001 /* USER CODE BEGIN Header */
00018 /* USER CODE END Header */
00019
00020
00021 #ifndef PCB_IO_H
00022 #define PCB_IO_H
00023
00024 #include "stm32f7xx_hal.h"
00025
00026 // Read SC_det and DIR GPIOs
00027 #define SC_DET_STATE()          (HAL_GPIO_ReadPin(SC_det_GPIO_Port, SC_det_Pin))
00028 #define DIR_STATE()              (HAL_GPIO_ReadPin(DIR_GPIO_Port, DIR_Pin))
00029
00030 // Read WRN GPIOs
00031 #define WRN_STATE(port, pin)     (HAL_GPIO_ReadPin(port, pin))
00032
00033 // Control ENABLE GPIOs
00034 #define ENABLE(port, pin)        do { HAL_GPIO_WritePin(port, pin, GPIO_PIN_SET); } while(0)
00035 #define DISABLE(port, pin)       do { HAL_GPIO_WritePin(port, pin, GPIO_PIN_RESET); } while(0)
00036
  
```

```

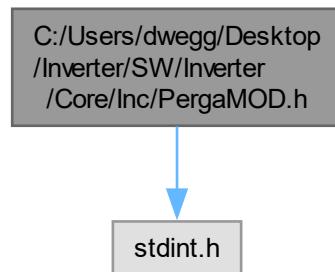
00037 // Define LED modes
00038 typedef enum {
00039     LED_MODE_BLINK_FAST,
00040     LED_MODE_BLINK_SLOW,
00041     LED_MODE_ON,
00042     LED_MODE_OFF
00043 } LEDMode;
00044
00045 typedef struct {
00046     GPIO_TypeDef *port;
00047     uint16_t pin;
00048     LEDMode mode;
00049 } LED;
00050
00051 // Declare LED variables as extern
00052 extern LED led_left;
00053 extern LED led_right;
00054 extern LED ledError;
00055
00056 // Function prototypes
00057 void handle_LED(LED *led, uint32_t ms_counter);
00058
00059 void handle_direction(volatile int8_t *dir_left, volatile int8_t *dir_right);
00060
00061 #endif /* PCB_IO_H */

```

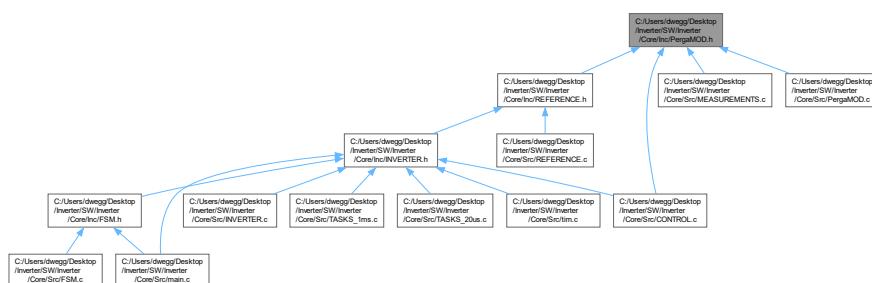
6.27 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/PergaMOD.h File Reference

#include "stdint.h"

Include dependency graph for PergaMOD.h:



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



Data Structures

- struct [pi_aw_struct](#)
PI Controller with internal saturation, anti-windup, and feedforward.
- struct [pi_struct](#)
PI Controller with external saturation and feedforward.
- struct [clarke3F_struct](#)
Clarke transformation for three-phase systems.
- struct [iclare3F_struct](#)
Inverse Clarke transformation for three-phase systems.
- struct [rot_struct](#)
Rotates the DQ axis in the opposite direction (clockwise).
- struct [irot_struct](#)
Inverse rotation (counterclockwise).
- struct [angle_struct](#)
Generates an angle based on a fixed frequency.
- struct [svpwm_struct](#)
Space Vector Pulse Width Modulation (SVPWM) implementation.
- struct [rampa_struct](#)
Single-ramp generator.
- struct [rampa_dual_struct](#)
Dual-ramp generator.
- struct [datalog_struct](#)
- struct [avg_struct_10](#)
Moving average filter for 10 samples.
- struct [RMS_struct](#)
Root Mean Square (RMS) calculation.
- struct [filtreLP_struct](#)
First-order low-pass filter.
- struct [step_struct](#)
Step function generator.

Macros

- #define [SQ2](#) 1.4142135624F
- #define [ISQ2](#) 0.7071067812F
- #define [SQ3](#) 1.7320508076F
- #define [ISQ3](#) 0.5773502692F
- #define [PI](#) 3.1415926536F
- #define [IPI](#) 0.3183098862F
- #define [PI2](#) 6.2831853072F
- #define [IPI2](#) 0.1591549431F
- #define [INV_DEG](#) 0.0027777778F
- #define [INV3](#) 0.3333333333F
- #define [DIV2](#) 0.5F
- #define [N_DATALOG](#) 256
Data logger for logging variables.

Functions

- void `pi_aw_calc` (volatile `pi_aw_struct` *v) `__attribute__((section(".ccmram")))`
Initializes the PI controller with anti-windup.
- void `pi_init` (volatile `pi_struct` *v) `__attribute__((section(".ccmram")))`
Initializes the PI controller.
- void `pi_calc` (volatile `pi_struct` *v) `__attribute__((section(".ccmram")))`
Calculates the output of the PI controller.
- void `pi_extsat_calc` (volatile `pi_struct` *v)
Calculates the output of the PI controller with external saturation.
- void `clarke3F_calc` (volatile `clarke3F_struct` *v) `__attribute__((section(".ccmram")))`
Calculates the Clarke transformation.
- void `iclarke3F_calc` (volatile `iclarke3F_struct` *v)
Calculates the inverse Clarke transformation.
- void `rot_calc` (volatile `rot_struct` *v) `__attribute__((section(".ccmram")))`
Calculates the rotation in the opposite direction.
- void `irot_calc` (volatile `irot_struct` *v) `__attribute__((section(".ccmram")))`
Calculates the inverse rotation.
- void `angle_calc` (volatile `angle_struct` *p) `__attribute__((section(".ccmram")))`
Calculates the angle generation.
- void `svpwm_calc` (volatile `svpwm_struct` *v) `__attribute__((section(".ccmram")))`
Calculates the SVPWM outputs.
- void `rampa_calc` (volatile `rampa_struct` *v) `__attribute__((section(".ccmram")))`
Calculates the output of the single ramp generator.
- void `rampa_dual_calc` (volatile `rampa_dual_struct` *v) `__attribute__((section(".ccmram")))`
Calculates the output of the dual ramp generator.
- void `datalog_calc` (volatile `datalog_struct` *dl)
Calculates the data log.
- void `avg_calc_10_samples` (volatile `avg_struct_10` *v)
Calculates the moving average for 10 samples.
- void `RMS_calc` (volatile `RMS_struct` *v) `__attribute__((section(".ccmram")))`
Calculates the RMS.
- void `filtreLP_init` (volatile `filtreLP_struct` *v)
Initializes the first-order low-pass filter.
- void `filtreLP_calc` (volatile `filtreLP_struct` *v) `__attribute__((section(".ccmram")))`
Calculates the output of the first-order low-pass filter.
- void `step_calc` (volatile `step_struct` *v) `__attribute__((section(".ccmram")))`
Calculates the output of the step function generator.

6.28 PergaMOD.h

[Go to the documentation of this file.](#)

```
00001 /*
00002  * @file PergaMOD.h
00003  * @brief Library consolidating all the hardware-independent libraries of CITCEA.
00004  * This library is based on Alexandria created by Gabriel Gross and Quim Lopez Mestre in September
00005  * 2006.
00006  * Created by Gabriel Gross, Daniel Heredero, and Tomas Lledo in December 2015.
00007  * Translated to floats by Lucas Bouzon in March 2020.
00008  */
00009 */
0010
0011
0012
```



```

00013
00014
00015
00016
00017 */
00018
00019 #ifndef __PERGAMON_FLOAT_H__
00020 #define __PERGAMON_FLOAT_H__
00021
00022
00023 #include "stdint.h"
00024
00025 #define SQ2      1.4142135624F
00026 #define ISQ2    0.7071067812F
00027 #define SQ3      1.7320508076F
00028 #define ISQ3    0.5773502692F
00029 #define PI       3.1415926536F
00030 #define IPI     0.3183098862F
00031 #define PI2      6.2831853072F
00032 #define IPI2    0.1591549431F
00033 #define INV_DEG 0.0027777778F
00034 #define INV3     0.3333333333F
00035 #define DIV2     0.5F
00036
00037
00038
00039
00040
00041
00042
00043
00044
00045
00046
00047
00048
00049 typedef struct
00050 {
00051     uint16_t      enable;
00052     float         Ts;
00053     float         Kp;
00054     float         Ki;
00055     float         Kaw;
00056     float         e[2];
00057     float         pi_consig;
00058     float         pi_fdb;
00059     float         pi_out_max;
00060     float         pi_out_min;
00061     float         pi_out_presat;
00062     float         pi_out_postsat;
00063     float         pi_out;
00064     float         pi_int[2];
00065     float         pi_ffw[2];
00066     void(*calc)();
00067 } pi_aw_struct;
00068
00069 void pi_aw_calc(volatile pi_aw_struct *v) __attribute__((section(".ccmram")));
00070
00071
00072
00073
00074
00075
00076
00077
00078 typedef struct
00079 {
00080     uint16_t      enable;
00081     float         Ts;
00082     float         Kp;
00083     float         Ki;
00084     float         K0;
00085     float         K1;
00086     float         e[2];
00087     float         pi_consig;
00088     float         pi_fdb;
00089     float         pi_out_max;
00090     float         pi_out_min;
00091     float         pi_out;
00092     float         pi_ffw[2];
00093     void(*init)();
00094     void(*calc)();
00095 } pi_struct;
00096
00097
00098
00099
00100
00101 void pi_init(volatile pi_struct *v) __attribute__((section(".ccmram")));
00102
00103
00104
00105
00106
00107 void pi_calc(volatile pi_struct *v) __attribute__((section(".ccmram")));
00108
00109
00110
00111
00112
00113 void pi_extsat_calc(volatile pi_struct *v);
00114
00115
00116
00117
00118
00119
00120
00121
00122
00123
00124
00125 typedef struct
00126 {
00127     float         a;
00128     float         b;
00129     float         D;
00130     float         Q;
00131     void(*calc)();
00132 } clarke3F_struct;
00133
00134
00135
00136
00137
00138 void clarke3F_calc(volatile clarke3F_struct *v) __attribute__((section(".ccmram")));
00139
00140
00141
00142
00143 typedef struct
00144 {
00145     float         D;
00146     float         Q;
00147     float         a;
00148     float         b;

```

```

00149     void(*calc) ();
00150 } iclarke3F_struct;
00151
00156 void iclarke3F_calc(volatile iclarke3F_struct *v);
00157
00161 typedef struct
00162 {
00163     float      D;
00164     float      Q;
00165     float      sinFi;
00166     float      cosFi;
00167     float      d;
00168     float      q;
00169     void(*calc) ();
00170 } rot_struct;
00171
00176 void rot_calc(volatile rot_struct *v) __attribute__( ( section ( ".ccmram" ) ) );
00177
00181 typedef struct
00182 {
00183     float      d;
00184     float      q;
00185     float      sinFi;
00186     float      cosFi;
00187     float      alpha;
00188     float      beta;
00189     void(*calc) ();
00190 } irot_struct;
00191
00196 void irot_calc(volatile irot_struct *v) __attribute__( ( section ( ".ccmram" ) ) );
00197
00208 typedef struct {
00209     float      freq;
00210     float      Ts;
00211     float      angle;
00212     void(*calc) ();
00213 } angle_struct;
00214
00219 void angle_calc(volatile angle_struct *p) __attribute__( ( section ( ".ccmram" ) ) );
00220
00224 typedef struct
00225 {
00226     float      alpha;
00227     float      beta;
00228     float      Da;
00229     float      Db;
00230     float      Dc;
00231     void(*calc) ();
00232 } svpwm_struct;
00233
00238 void svpwm_calc(volatile svpwm_struct *v) __attribute__( ( section ( ".ccmram" ) ) );
00239
00249 typedef struct
00250 {
00251     float      in;
00252     float      out;
00253     float      Incr;
00254     uint8_t    enable;
00255     void(*calc) ();
00256 } rampa_struct;
00257
00261 typedef struct
00262 {
00263     float      in;
00264     float      out;
00265     float      Incr;
00266     float      Decr;
00267     uint8_t    enable;
00268     void(*calc) ();
00269 } rampa_dual_struct;
00270
00275 void rampa_calc(volatile rampa_struct *v) __attribute__( ( section ( ".ccmram" ) ) );
00276
00281 void rampa_dual_calc(volatile rampa_dual_struct *v) __attribute__( ( section ( ".ccmram" ) ) );
00282
00287 #define N_DATALOG 256
00289 typedef struct
00290 {
00291     uint16_t    i;
00292     uint16_t    j;
00293     uint16_t    estat;
00294     uint16_t    prescaler;
00295     float      *var;
00296     void(*calc) ();
00297     float      log[N_DATALOG];
00298 } datalog_struct;
00299

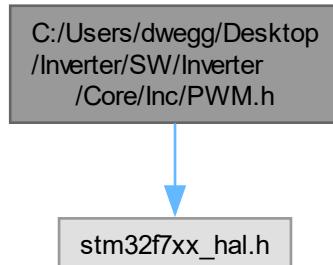
```

```
00304 void datalog_calc(volatile datalog_struct *dl);
00305
00309 typedef struct
00310 {
00311     float      out;
00312     float      in[10];
00313 }avg_struct_10;
00314
00319 void avg_calc_10_samples(volatile avg_struct_10 *v);
00320
00324 typedef struct {
00325     float      T_exec;
00326     float      Measure;
00327     float      Sq_Sum;
00328     float      Out_RMS;
00329     float      Freq;
00330     float      Angle;
00331     float      Angle_ant;
00332 } RMS_struct;
00333
00338 void RMS_calc(volatile RMS_struct *v) __attribute__( ( section ( ".ccmram" ) ) );
00339
00343 typedef struct
00344 {
00345     float      in;
00346     float      out;
00347     float      alfa;
00348     float      Ts;
00349     float      fc;
00350     uint16_t   enable;
00351     void(*init)();
00352     void(*calc)();
00353 } filtreLP_struct;
00354
00359 void filtreLP_init(volatile filtreLP_struct *v);
00360
00365 void filtreLP_calc(volatile filtreLP_struct *v) __attribute__( ( section ( ".ccmram" ) ) );
00366
00377 typedef struct
00378 {
00379     float      fs;
00380     float      In;
00381     float      Out;
00382     float      Step;
00383     float      t_step;
00384     uint32_t   Pulses;
00385     uint32_t   Counter;
00386     uint16_t   enable;
00387     void(*calc)();
00388 } step_struct;
00389
00394 void step_calc(volatile step_struct *v) __attribute__( ( section ( ".ccmram" ) ) );
00395
00398 #endif // __PERGAMON_FLOAT_H__
```

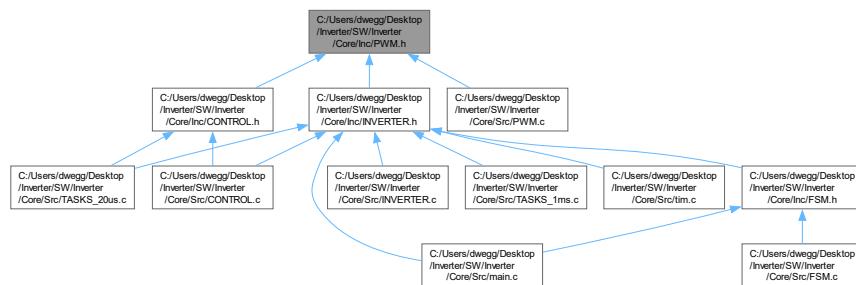
6.29 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/PWM.h File Reference

Header file for controlling PWM output.

```
#include "stm32f7xx_hal.h"
Include dependency graph for PWM.h:
```



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



Data Structures

- struct **Duties**

Structure to hold PWM configuration parameters.

Functions

- void **enable_PWM** (TIM_HandleTypeDef *htim)
Enable PWM output.
- void **disable_PWM** (TIM_HandleTypeDef *htim)
Disable PWM output.
- void **update_PWM** (TIM_HandleTypeDef *htim, **Duties** duties)
Set PWM duty cycles.

6.29.1 Detailed Description

Header file for controlling PWM output.

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6.29.2 Function Documentation

6.29.2.1 disable_PWM()

```
void disable_PWM (  
    TIM_HandleTypeDef * htim )
```

Disable PWM output.

This function disables PWM output for the specified timer.

Parameters

<i>htim</i>	Pointer to the TIM_HandleTypeDef structure.
-------------	---

6.29.2.2 enable_PWM()

```
void enable_PWM (  
    TIM_HandleTypeDef * htim )
```

Enable PWM output.

This function enables PWM output for the specified timer.

Parameters

<i>htim</i>	Pointer to the TIM_HandleTypeDef structure.
-------------	---

6.29.2.3 update_PWM()

```
void update_PWM (  
    TIM_HandleTypeDef * htim,  
    Duties duties )
```

Set PWM duty cycles.

This function sets the duty cycles for the PWM channels.

Parameters

<i>htim</i>	Pointer to the TIM_HandleTypeDef structure.
<i>duties</i>	Duties structure containing duty cycle values.

Here is the caller graph for this function:



6.30 PWM.h

[Go to the documentation of this file.](#)

```

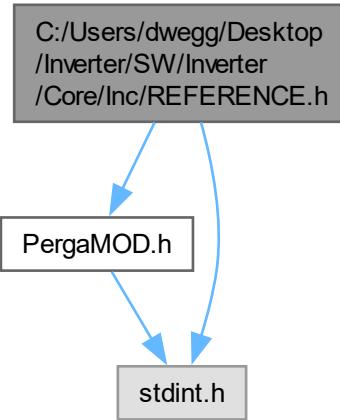
00001 /* USER CODE BEGIN Header */
00018 /* USER CODE END Header */
00019
00020 #ifndef PWM_H
00021 #define PWM_H
00022
00023 #include "stm32f7xx_hal.h"
00024
00028 typedef struct {
00029     float Da;
00030     float Db;
00031     float Dc;
00032 } Duties;
00033
00041 void enable_PWM(TIM_HandleTypeDef *htim);
00042
00050 void disable_PWM(TIM_HandleTypeDef *htim);
00051
00052
00061 void update_PWM(TIM_HandleTypeDef *htim, Duties duties);
00062
00063 #endif /* PWM_H */
  
```

6.31 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/REFERENCE.h File Reference

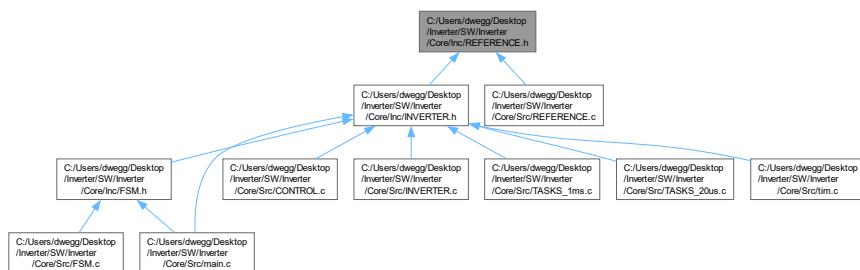
Header file for torque reference handling.

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

Include dependency graph for REFERENCE.h:



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



Functions

- float `set_torque_direction` (float torque_ref, int8_t direction)
Set torque direction based on inverter direction.
- float `saturate_symmetric` (float ref, float max_value)
Symmetrically saturate a reference value.
- float `limit_torque_to_prevent_overspeed` (float speed_max, float speed_meas, float torque_ref_pre, volatile pi_struct *loop_speed)
Speed loop acts as a torque saturation, reducing torque in order to limit the maximum speed.

6.31.1 Detailed Description

Header file for torque reference handling.

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6.31.2 Function Documentation

6.31.2.1 limit_torque_to_prevent_overspeed()

```
float limit_torque_to_prevent_overspeed (
    float speed_max,
    float speed_meas,
    float torque_ref_pre,
    volatile pi_struct * loop_speed )
```

Speed loop acts as a torque saturation, reducing torque in order to limit the maximum speed.

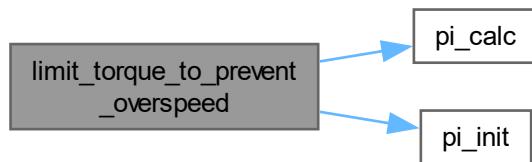
Parameters

in	<i>speed_max</i>	The maximum speed value in RPM.
in	<i>speed_meas</i>	The measured speed value in RPM.
in	<i>torque_ref_pre</i>	The torque reference value before this saturation.
in	<i>loop_speed</i>	Pointer to the speed PI controller structure.

Returns

The limited torque reference value after this saturation.

Here is the call graph for this function:



6.31.2.2 saturate_symmetric()

```
float saturate_symmetric (
    float ref,
    float max_value )
```

Symmetrically saturate a reference value.

This function symmetrically saturates a reference value based on the maximum allowed value. If the reference value exceeds the maximum allowed value, it is saturated to the maximum value. If the reference value is less than the negative of the maximum allowed value, it is saturated to the negative of the maximum value.

Parameters

in	<i>ref</i>	The reference value to saturate.
in	<i>max_value</i>	The maximum allowed value for saturation.

Returns

The saturated reference value.

6.31.2.3 set_torque_direction()

```
float set_torque_direction (
    float torque_ref,
    int8_t direction )
```

Set torque direction based on inverter direction.

This function adjusts the torque reference based on the direction of the inverter. If the inverter is set to rotate counterclockwise (CCW), positive torque represents braking. If the inverter is set to rotate clockwise (CW), positive torque represents traction.

Parameters

in	<i>torque_ref</i>	The torque reference value to adjust.
in	<i>direction</i>	Pointer to the direction of the inverter (1 for CW, -1 for CCW).

Returns

The adjusted torque reference value.

This function adjusts the torque reference based on the desired direction. If the motor is set to rotate counter-clockwise (CCW), positive torque represents braking. If the motor is set to rotate clockwise (CW), positive torque represents traction.

Parameters

in	<i>torque_ref</i>	The torque reference value to adjust.
in	<i>direction</i>	Pointer to the direction of the inverter (1 for CW, -1 for CCW).

Returns

The adjusted torque reference value.

6.32 REFERENCE.h

[Go to the documentation of this file.](#)

```
00001 /* USER CODE BEGIN Header */
00018 /* USER CODE END Header */
00019
00020 #ifndef REFERENCE_H
00021 #define REFERENCE_H
00022
00023 #include <PergaMOD.h>
00024 #include <stdint.h>
00025
00037 float set_torque_direction(float torque_ref, int8_t direction);
00038
00050 float saturate_symmetric(float ref, float max_value);
00051
00060 float limit_torque_to_prevent_overspeed(float speed_max, float speed_meas, float torque_ref_pre,
     volatile pi_struct *loop_speed);
00061
00062 #endif /* REFERENCE_H */
```

6.33 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/stm32f7xx_← hal_conf.h File Reference

```
#include "stm32f7xx_hal_rcc.h"
#include "stm32f7xx_hal_exti.h"
#include "stm32f7xx_hal_gpio.h"
#include "stm32f7xx_hal_dma.h"
#include "stm32f7xx_hal_cortex.h"
#include "stm32f7xx_hal_adc.h"
#include "stm32f7xx_hal_can.h"
#include "stm32f7xx_hal_dac.h"
#include "stm32f7xx_hal_flash.h"
#include "stm32f7xx_hal_i2c.h"
#include "stm32f7xx_hal_pwr.h"
#include "stm32f7xx_hal_tim.h"
```

Include dependency graph for stm32f7xx_hal_conf.h:



Macros

- [#define HAL_MODULE_ENABLED](#)
This is the list of modules to be used in the HAL driver.
- [#define HAL_ADC_MODULE_ENABLED](#)
- [#define HAL_CAN_MODULE_ENABLED](#)
- [#define HAL_DAC_MODULE_ENABLED](#)
- [#define HAL_TIM_MODULE_ENABLED](#)
- [#define HAL_GPIO_MODULE_ENABLED](#)
- [#define HAL_EXTI_MODULE_ENABLED](#)
- [#define HAL_DMA_MODULE_ENABLED](#)
- [#define HAL_RCC_MODULE_ENABLED](#)
- [#define HAL_FLASH_MODULE_ENABLED](#)
- [#define HAL_PWR_MODULE_ENABLED](#)

- #define HAL_I2C_MODULE_ENABLED
- #define HAL_CORTEX_MODULE_ENABLED
- #define HSE_VALUE ((uint32_t)20000000U)

Adjust the value of External High Speed oscillator (HSE) used in your application. This value is used by the RCC HAL module to compute the system frequency (when HSE is used as system clock source, directly or through the PLL).
- #define HSE_STARTUP_TIMEOUT ((uint32_t)100U)
- #define HSI_VALUE ((uint32_t)16000000U)

Internal High Speed oscillator (HSI) value. This value is used by the RCC HAL module to compute the system frequency (when HSI is used as system clock source, directly or through the PLL).
- #define LSI_VALUE ((uint32_t)32000U)

Internal Low Speed oscillator (LSI) value.
- #define LSE_VALUE ((uint32_t)32768U)

External Low Speed oscillator (LSE) value.
- #define LSE_STARTUP_TIMEOUT ((uint32_t)5000U)
- #define EXTERNAL_CLOCK_VALUE ((uint32_t)12288000U)

External clock source for I2S peripheral This value is used by the I2S HAL module to compute the I2S clock source frequency, this source is inserted directly through I2S_CKIN pad.
- #define VDD_VALUE 3300U

This is the HAL system configuration section.

 - #define TICK_INT_PRIORITY ((uint32_t)15U)
 - #define USERTOS 0U
 - #define PREFETCH_ENABLE 0U
 - #define ART_ACCELERATOR_ENABLE 0U /* To enable instruction cache and prefetch */
 - #define USE_HAL_ADC_REGISTER_CALLBACKS 0U /* ADC register callback disabled */
 - #define USE_HAL_CAN_REGISTER_CALLBACKS 0U /* CAN register callback disabled */
 - #define USE_HAL_CEC_REGISTER_CALLBACKS 0U /* CEC register callback disabled */
 - #define USE_HAL_CRYP_REGISTER_CALLBACKS 0U /* CRYP register callback disabled */
 - #define USE_HAL_DAC_REGISTER_CALLBACKS 0U /* DAC register callback disabled */
 - #define USE_HAL_DCMI_REGISTER_CALLBACKS 0U /* DCMI register callback disabled */
 - #define USE_HAL_DFSDM_REGISTER_CALLBACKS 0U /* DFSDM register callback disabled */
 - #define USE_HAL_DMA2D_REGISTER_CALLBACKS 0U /* DMA2D register callback disabled */
 - #define USE_HAL_DSI_REGISTER_CALLBACKS 0U /* DSI register callback disabled */
 - #define USE_HAL_ETH_REGISTER_CALLBACKS 0U /* ETH register callback disabled */
 - #define USE_HAL_HASH_REGISTER_CALLBACKS 0U /* HASH register callback disabled */
 - #define USE_HAL_HCD_REGISTER_CALLBACKS 0U /* HCD register callback disabled */
 - #define USE_HAL_I2C_REGISTER_CALLBACKS 0U /* I2C register callback disabled */
 - #define USE_HAL_I2S_REGISTER_CALLBACKS 0U /* I2S register callback disabled */
 - #define USE_HAL_IRDA_REGISTER_CALLBACKS 0U /* IRDA register callback disabled */
 - #define USE_HAL_JPEG_REGISTER_CALLBACKS 0U /* JPEG register callback disabled */
 - #define USE_HAL_LPTIM_REGISTER_CALLBACKS 0U /* LPTIM register callback disabled */
 - #define USE_HAL_LTDC_REGISTER_CALLBACKS 0U /* LTDC register callback disabled */
 - #define USE_HAL_MDIOS_REGISTER_CALLBACKS 0U /* MDIOS register callback disabled */
 - #define USE_HAL_MMCHS_REGISTER_CALLBACKS 0U /* MMC register callback disabled */
 - #define USE_HAL_NAND_REGISTER_CALLBACKS 0U /* NAND register callback disabled */
 - #define USE_HAL_NOR_REGISTER_CALLBACKS 0U /* NOR register callback disabled */
 - #define USE_HAL_PCD_REGISTER_CALLBACKS 0U /* PCD register callback disabled */
 - #define USE_HAL_QSPI_REGISTER_CALLBACKS 0U /* QSPI register callback disabled */
 - #define USE_HAL_RNG_REGISTER_CALLBACKS 0U /* RNG register callback disabled */
 - #define USE_HAL_RTC_REGISTER_CALLBACKS 0U /* RTC register callback disabled */
 - #define USE_HAL_SAI_REGISTER_CALLBACKS 0U /* SAI register callback disabled */
 - #define USE_HAL_SD_REGISTER_CALLBACKS 0U /* SD register callback disabled */
 - #define USE_HAL_SMARTCARD_REGISTER_CALLBACKS 0U /* SMARTCARD register callback disabled */
 - #define USEHAL_SDRAM_REGISTER_CALLBACKS 0U /* SDRAM register callback disabled */

- #define USE_HAL_SRAM_REGISTER_CALLBACKS 0U /* SRAM register callback disabled */
- #define USE_HAL_SPDIFRX_REGISTER_CALLBACKS 0U /* SPDIFRX register callback disabled */
- #define USE_HAL_SMBUS_REGISTER_CALLBACKS 0U /* SMBUS register callback disabled */
- #define USE_HAL_SPI_REGISTER_CALLBACKS 0U /* SPI register callback disabled */
- #define USE_HAL_TIM_REGISTER_CALLBACKS 0U /* TIM register callback disabled */
- #define USE_HAL_UART_REGISTER_CALLBACKS 0U /* UART register callback disabled */
- #define USE_HAL_USART_REGISTER_CALLBACKS 0U /* USART register callback disabled */
- #define USE_HAL_WWDG_REGISTER_CALLBACKS 0U /* WWDG register callback disabled */
- #define MAC_ADDR0 2U

Uncomment the line below to expand the "assert_param" macro in the HAL drivers code.
- #define MAC_ADDR1 0U
- #define MAC_ADDR2 0U
- #define MAC_ADDR3 0U
- #define MAC_ADDR4 0U
- #define MAC_ADDR5 0U
- #define ETH_RX_BUF_SIZE ETH_MAX_PACKET_SIZE /* buffer size for receive */
- #define ETH_TX_BUF_SIZE ETH_MAX_PACKET_SIZE /* buffer size for transmit */
- #define ETH_RXBUFN ((uint32_t)4U) /* 4 Rx buffers of size ETH_RX_BUF_SIZE */
- #define ETH_TXBUFN ((uint32_t)4U) /* 4 Tx buffers of size ETH_TX_BUF_SIZE */
- #define DP83848_PHY_ADDRESS
- #define PHY_RESET_DELAY ((uint32_t)0x000000FFU)
- #define PHY_CONFIG_DELAY ((uint32_t)0x00000FFFU)
- #define PHY_READ_TO ((uint32_t)0x0000FFFFU)
- #define PHY_WRITE_TO ((uint32_t)0x0000FFFFU)
- #define PHY_BCR ((uint16_t)0x0000U)
- #define PHY_BSR ((uint16_t)0x0001U)
- #define PHY_RESET ((uint16_t)0x8000U)
- #define PHY_LOOPBACK ((uint16_t)0x4000U)
- #define PHY_FULLDUPLEX_100M ((uint16_t)0x2100U)
- #define PHY_HALFDUPLEX_100M ((uint16_t)0x2000U)
- #define PHY_FULLDUPLEX_10M ((uint16_t)0x0100U)
- #define PHY_HALFDUPLEX_10M ((uint16_t)0x0000U)
- #define PHY_AUTONEGOTIATION ((uint16_t)0x1000U)
- #define PHY_RESTART_AUTONEGOTIATION ((uint16_t)0x0200U)
- #define PHY_POWERDOWN ((uint16_t)0x0800U)
- #define PHY_ISOLATE ((uint16_t)0x0400U)
- #define PHY_AUTONEGO_COMPLETE ((uint16_t)0x0020U)
- #define PHY_LINKED_STATUS ((uint16_t)0x0004U)
- #define PHY_JABBER_DETECTION ((uint16_t)0x0002U)
- #define PHY_SR ((uint16_t))
- #define PHY_SPEED_STATUS ((uint16_t))
- #define PHY_DUPLEX_STATUS ((uint16_t))
- #define USE_SPI_CRC 0U
- #define assert_param(expr) ((void)0U)

Include module's header file.

6.33.1 Macro Definition Documentation

6.33.1.1 ART_ACCELERATOR_ENABLE

```
#define ART_ACCELERATOR_ENABLE 0U /* To enable instruction cache and prefetch */
```

6.33.1.2 assert_param

```
#define assert_param(
    expr ) ((void)0U)
```

Include module's header file.

6.33.1.3 DP83848_PHY_ADDRESS

```
#define DP83848_PHY_ADDRESS
```

6.33.1.4 ETH_RX_BUF_SIZE

```
#define ETH_RX_BUF_SIZE ETH_MAX_PACKET_SIZE /* buffer size for receive */
```

6.33.1.5 ETH_RXBUFNB

```
#define ETH_RXBUFNB ((uint32_t)4U) /* 4 Rx buffers of size ETH_RX_BUF_SIZE */
```

6.33.1.6 ETH_TX_BUF_SIZE

```
#define ETH_TX_BUF_SIZE ETH_MAX_PACKET_SIZE /* buffer size for transmit */
```

6.33.1.7 ETH_TXBUFNB

```
#define ETH_TXBUFNB ((uint32_t)4U) /* 4 Tx buffers of size ETH_TX_BUF_SIZE */
```

6.33.1.8 EXTERNAL_CLOCK_VALUE

```
#define EXTERNAL_CLOCK_VALUE ((uint32_t)12288000U)
```

External clock source for I2S peripheral This value is used by the I2S HAL module to compute the I2S clock source frequency, this source is inserted directly through I2S_CKIN pad.

Value of the Internal oscillator in Hz

6.33.1.9 HAL_ADC_MODULE_ENABLED

```
#define HAL_ADC_MODULE_ENABLED
```

6.33.1.10 HAL_CAN_MODULE_ENABLED

```
#define HAL_CAN_MODULE_ENABLED
```

6.33.1.11 HAL_CORTEX_MODULE_ENABLED

```
#define HAL_CORTEX_MODULE_ENABLED
```

6.33.1.12 HAL_DAC_MODULE_ENABLED

```
#define HAL_DAC_MODULE_ENABLED
```

6.33.1.13 HAL_DMA_MODULE_ENABLED

```
#define HAL_DMA_MODULE_ENABLED
```

6.33.1.14 HAL_EXTI_MODULE_ENABLED

```
#define HAL_EXTI_MODULE_ENABLED
```

6.33.1.15 HAL_FLASH_MODULE_ENABLED

```
#define HAL_FLASH_MODULE_ENABLED
```

6.33.1.16 HAL_GPIO_MODULE_ENABLED

```
#define HAL_GPIO_MODULE_ENABLED
```

6.33.1.17 HAL_I2C_MODULE_ENABLED

```
#define HAL_I2C_MODULE_ENABLED
```

6.33.1.18 HAL_MODULE_ENABLED

```
#define HAL_MODULE_ENABLED
```

This is the list of modules to be used in the HAL driver.

6.33.1.19 HAL_PWR_MODULE_ENABLED

```
#define HAL_PWR_MODULE_ENABLED
```

6.33.1.20 HAL_RCC_MODULE_ENABLED

```
#define HAL_RCC_MODULE_ENABLED
```

6.33.1.21 HAL_TIM_MODULE_ENABLED

```
#define HAL_TIM_MODULE_ENABLED
```

6.33.1.22 HSE_STARTUP_TIMEOUT

```
#define HSE_STARTUP_TIMEOUT ((uint32_t)100U)
```

Time out for HSE start up, in ms

6.33.1.23 HSE_VALUE

```
#define HSE_VALUE ((uint32_t)20000000U)
```

Adjust the value of External High Speed oscillator (HSE) used in your application. This value is used by the RCC HAL module to compute the system frequency (when HSE is used as system clock source, directly or through the PLL).

Value of the External oscillator in Hz

6.33.1.24 HSI_VALUE

```
#define HSI_VALUE ((uint32_t)16000000U)
```

Internal High Speed oscillator (HSI) value. This value is used by the RCC HAL module to compute the system frequency (when HSI is used as system clock source, directly or through the PLL).

Value of the Internal oscillator in Hz

6.33.1.25 LSE_STARTUP_TIMEOUT

```
#define LSE_STARTUP_TIMEOUT ((uint32_t)5000U)
```

Time out for LSE start up, in ms

6.33.1.26 LSE_VALUE

```
#define LSE_VALUE ((uint32_t)32768U)
```

External Low Speed oscillator (LSE) value.

< Value of the Internal Low Speed oscillator in Hz The real value may vary depending on the variations in voltage and temperature.

Value of the External Low Speed oscillator in Hz

6.33.1.27 LSI_VALUE

```
#define LSI_VALUE ((uint32_t)32000U)
```

Internal Low Speed oscillator (LSI) value.

LSI Typical Value in Hz

6.33.1.28 MAC_ADDR0

```
#define MAC_ADDR0 2U
```

Uncomment the line below to expand the "assert_param" macro in the HAL drivers code.

6.33.1.29 MAC_ADDR1

```
#define MAC_ADDR1 0U
```

6.33.1.30 MAC_ADDR2

```
#define MAC_ADDR2 0U
```

6.33.1.31 MAC_ADDR3

```
#define MAC_ADDR3 0U
```

6.33.1.32 MAC_ADDR4

```
#define MAC_ADDR4 0U
```

6.33.1.33 MAC_ADDR5

```
#define MAC_ADDR5 0U
```

6.33.1.34 PHY_AUTONEGO_COMPLETE

```
#define PHY_AUTONEGO_COMPLETE ((uint16_t)0x0020U)
```

Auto-Negotiation process completed

6.33.1.35 PHY_AUTONEGOTIATION

```
#define PHY_AUTONEGOTIATION ((uint16_t)0x1000U)
```

Enable auto-negotiation function

6.33.1.36 PHY_BCR

```
#define PHY_BCR ((uint16_t)0x0000U)
```

Transceiver Basic Control Register

6.33.1.37 PHY_BSR

```
#define PHY_BSR ((uint16_t)0x0001U)
```

Transceiver Basic Status Register

6.33.1.38 PHY_CONFIG_DELAY

```
#define PHY_CONFIG_DELAY ((uint32_t)0x00000FFFU)
```

6.33.1.39 PHY_DUPLEX_STATUS

```
#define PHY_DUPLEX_STATUS ((uint16_t))
```

PHY Duplex mask

6.33.1.40 PHY_FULLDUPLEX_100M

```
#define PHY_FULLDUPLEX_100M ((uint16_t)0x2100U)
```

Set the full-duplex mode at 100 Mb/s

6.33.1.41 PHY_FULLDUPLEX_10M

```
#define PHY_FULLDUPLEX_10M ((uint16_t)0x0100U)
```

Set the full-duplex mode at 10 Mb/s

6.33.1.42 PHY_HALFDUPLEX_100M

```
#define PHY_HALFDUPLEX_100M ((uint16_t)0x2000U)
```

Set the half-duplex mode at 100 Mb/s

6.33.1.43 PHY_HALFDUPLEX_10M

```
#define PHY_HALFDUPLEX_10M ((uint16_t)0x0000U)
```

Set the half-duplex mode at 10 Mb/s

6.33.1.44 PHY_ISOLATE

```
#define PHY_ISOLATE ((uint16_t)0x0400U)
```

Isolate PHY from MII

6.33.1.45 PHY_JABBER_DETECTION

```
#define PHY_JABBER_DETECTION ((uint16_t)0x0002U)
```

Jabber condition detected

6.33.1.46 PHY_LINKED_STATUS

```
#define PHY_LINKED_STATUS ((uint16_t)0x0004U)
```

Valid link established

6.33.1.47 PHY_LOOPBACK

```
#define PHY_LOOPBACK ((uint16_t)0x4000U)
```

Select loop-back mode

6.33.1.48 PHY_POWERDOWN

```
#define PHY_POWERDOWN ((uint16_t)0x0800U)
```

Select the power down mode

6.33.1.49 PHY_READ_TO

```
#define PHY_READ_TO ((uint32_t)0x0000FFFFU)
```

6.33.1.50 PHY_RESET

```
#define PHY_RESET ((uint16_t)0x8000U)
```

PHY Reset

6.33.1.51 PHY_RESET_DELAY

```
#define PHY_RESET_DELAY ((uint32_t)0x000000FFU)
```

6.33.1.52 PHY_RESTART_AUTONEGOTIATION

```
#define PHY_RESTART_AUTONEGOTIATION ((uint16_t)0x0200U)
```

Restart auto-negotiation function

6.33.1.53 PHY_SPEED_STATUS

```
#define PHY_SPEED_STATUS ((uint16_t))
```

PHY Speed mask

6.33.1.54 PHY_SR

```
#define PHY_SR ((uint16_t))
```

PHY status register Offset

6.33.1.55 PHY_WRITE_TO

```
#define PHY_WRITE_TO ((uint32_t)0x0000FFFFU)
```

6.33.1.56 PREFETCH_ENABLE

```
#define PREFETCH_ENABLE 0U
```

6.33.1.57 TICK_INT_PRIORITY

```
#define TICK_INT_PRIORITY ((uint32_t)15U)
```

tick interrupt priority

6.33.1.58 USE_HAL_ADC_REGISTER_CALLBACKS

```
#define USE_HAL_ADC_REGISTER_CALLBACKS 0U /* ADC register callback disabled */
```

6.33.1.59 USE_HAL_CAN_REGISTER_CALLBACKS

```
#define USE_HAL_CAN_REGISTER_CALLBACKS 0U /* CAN register callback disabled */
```

6.33.1.60 USE_HAL_CEC_REGISTER_CALLBACKS

```
#define USE_HAL_CEC_REGISTER_CALLBACKS 0U /* CEC register callback disabled */
```

6.33.1.61 USE_HAL_CRYP_REGISTER_CALLBACKS

```
#define USE_HAL_CRYP_REGISTER_CALLBACKS 0U /* CRYP register callback disabled */
```

6.33.1.62 USE_HAL_DAC_REGISTER_CALLBACKS

```
#define USE_HAL_DAC_REGISTER_CALLBACKS 0U /* DAC register callback disabled */
```

6.33.1.63 USE_HAL_DCMI_REGISTER_CALLBACKS

```
#define USE_HAL_DCMI_REGISTER_CALLBACKS 0U /* DCMI register callback disabled */
```

6.33.1.64 USE_HAL_DFSDM_REGISTER_CALLBACKS

```
#define USE_HAL_DFSDM_REGISTER_CALLBACKS 0U /* DFSDM register callback disabled */
```

6.33.1.65 USE_HAL_DMA2D_REGISTER_CALLBACKS

```
#define USE_HAL_DMA2D_REGISTER_CALLBACKS 0U /* DMA2D register callback disabled */
```

6.33.1.66 USE_HAL_DSI_REGISTER_CALLBACKS

```
#define USE_HAL_DSI_REGISTER_CALLBACKS 0U /* DSI register callback disabled */
```

6.33.1.67 USE_HAL_ETH_REGISTER_CALLBACKS

```
#define USE_HAL_ETH_REGISTER_CALLBACKS 0U /* ETH register callback disabled */
```

6.33.1.68 USE_HAL_HASH_REGISTER_CALLBACKS

```
#define USE_HAL_HASH_REGISTER_CALLBACKS 0U /* HASH register callback disabled */
```

6.33.1.69 USE_HAL_HCD_REGISTER_CALLBACKS

```
#define USE_HAL_HCD_REGISTER_CALLBACKS 0U /* HCD register callback disabled */
```

6.33.1.70 USE_HAL_I2C_REGISTER_CALLBACKS

```
#define USE_HAL_I2C_REGISTER_CALLBACKS 0U /* I2C register callback disabled */
```

6.33.1.71 USE_HAL_I2S_REGISTER_CALLBACKS

```
#define USE_HAL_I2S_REGISTER_CALLBACKS 0U /* I2S register callback disabled */
```

6.33.1.72 USE_HAL_IRDA_REGISTER_CALLBACKS

```
#define USE_HAL_IRDA_REGISTER_CALLBACKS 0U /* IRDA register callback disabled */
```

6.33.1.73 USE_HAL_JPEG_REGISTER_CALLBACKS

```
#define USE_HAL_JPEG_REGISTER_CALLBACKS 0U /* JPEG register callback disabled */
```

6.33.1.74 USE_HAL_LPTIM_REGISTER_CALLBACKS

```
#define USE_HAL_LPTIM_REGISTER_CALLBACKS 0U /* LPTIM register callback disabled */
```

6.33.1.75 USE_HAL_LTDC_REGISTER_CALLBACKS

```
#define USE_HAL_LTDC_REGISTER_CALLBACKS 0U /* LTDC register callback disabled */
```

6.33.1.76 USE_HAL_MDIOS_REGISTER_CALLBACKS

```
#define USE_HAL_MDIOS_REGISTER_CALLBACKS 0U /* MDIOS register callback disabled */
```

6.33.1.77 USE_HAL_MMC_REGISTER_CALLBACKS

```
#define USE_HAL_MMC_REGISTER_CALLBACKS 0U /* MMC register callback disabled */
```

6.33.1.78 USE_HAL_NAND_REGISTER_CALLBACKS

```
#define USE_HAL_NAND_REGISTER_CALLBACKS 0U /* NAND register callback disabled */
```

6.33.1.79 USE_HAL_NOR_REGISTER_CALLBACKS

```
#define USE_HAL_NOR_REGISTER_CALLBACKS 0U /* NOR register callback disabled */
```

6.33.1.80 USE_HAL_PCD_REGISTER_CALLBACKS

```
#define USE_HAL_PCD_REGISTER_CALLBACKS 0U /* PCD register callback disabled */
```

6.33.1.81 USE_HAL_QSPI_REGISTER_CALLBACKS

```
#define USE_HAL_QSPI_REGISTER_CALLBACKS 0U /* QSPI register callback disabled */
```

6.33.1.82 USE_HAL_RNG_REGISTER_CALLBACKS

```
#define USE_HAL_RNG_REGISTER_CALLBACKS 0U /* RNG register callback disabled */
```

6.33.1.83 USE_HAL_RTC_REGISTER_CALLBACKS

```
#define USE_HAL_RTC_REGISTER_CALLBACKS 0U /* RTC register callback disabled */
```

6.33.1.84 USE_HAL_SAI_REGISTER_CALLBACKS

```
#define USE_HAL_SAI_REGISTER_CALLBACKS 0U /* SAI register callback disabled */
```

6.33.1.85 USE_HAL_SD_REGISTER_CALLBACKS

```
#define USE_HAL_SD_REGISTER_CALLBACKS 0U /* SD register callback disabled */
```

6.33.1.86 USE_HAL_SDRAM_REGISTER_CALLBACKS

```
#define USE_HAL_SDRAM_REGISTER_CALLBACKS 0U /* SDRAM register callback disabled */
```

6.33.1.87 USE_HAL_SMARTCARD_REGISTER_CALLBACKS

```
#define USE_HAL_SMARTCARD_REGISTER_CALLBACKS 0U /* SMARTCARD register callback disabled */
```

6.33.1.88 USE_HAL_SMBUS_REGISTER_CALLBACKS

```
#define USE_HAL_SMBUS_REGISTER_CALLBACKS 0U /* SMBUS register callback disabled */
```

6.33.1.89 USE_HAL_SPDIFRX_REGISTER_CALLBACKS

```
#define USE_HAL_SPDIFRX_REGISTER_CALLBACKS 0U /* SPDIFRX register callback disabled */
```

6.33.1.90 USE_HAL_SPI_REGISTER_CALLBACKS

```
#define USE_HAL_SPI_REGISTER_CALLBACKS 0U /* SPI register callback disabled */
```

6.33.1.91 USE_HAL_SRAM_REGISTER_CALLBACKS

```
#define USE_HAL_SRAM_REGISTER_CALLBACKS 0U /* SRAM register callback disabled */
```

6.33.1.92 USE_HAL_TIM_REGISTER_CALLBACKS

```
#define USE_HAL_TIM_REGISTER_CALLBACKS 0U /* TIM register callback disabled */
```

6.33.1.93 USE_HAL_UART_REGISTER_CALLBACKS

```
#define USE_HAL_UART_REGISTER_CALLBACKS 0U /* UART register callback disabled */
```

6.33.1.94 USE_HAL_USART_REGISTER_CALLBACKS

```
#define USE_HAL_USART_REGISTER_CALLBACKS 0U /* USART register callback disabled */
```

6.33.1.95 USE_HAL_WWDG_REGISTER_CALLBACKS

```
#define USE_HAL_WWDG_REGISTER_CALLBACKS 0U /* WWDG register callback disabled */
```

6.33.1.96 USE_RTOS

```
#define USE_RTOS 0U
```

6.33.1.97 USE_SPI_CRC

```
#define USE_SPI_CRC 0U
```

6.33.1.98 VDD_VALUE

```
#define VDD_VALUE 3300U
```

This is the HAL system configuration section.

Value of VDD in mv

6.34 stm32f7xx_hal_conf.h

[Go to the documentation of this file.](#)

```
00001 /* USER CODE BEGIN Header */
00021 /* USER CODE END Header */
00022
00023 /* Define to prevent recursive inclusion -----*/
00024 #ifndef __STM32F7XX_HAL_CONF_H
00025 #define __STM32F7XX_HAL_CONF_H
00026
00027 #ifdef __cplusplus
00028 extern "C" {
00029 #endif
00030
00031 /* Exported types -----*/
00032 /* Exported constants -----*/
00033
00034 /* ##### Module Selection ##### */
00038 #define HAL_MODULE_ENABLED
00039
00040 /* #define HAL_CRYPT_MODULE_ENABLED */
00041 #define HAL_ADC_MODULE_ENABLED
00042 #define HAL_CAN_MODULE_ENABLED
00043 /* #define HAL_CEC_MODULE_ENABLED */
00044 /* #define HAL_CRC_MODULE_ENABLED */
00045 #define HAL_DAC_MODULE_ENABLED
00046 /* #define HAL_DCMI_MODULE_ENABLED */
00047 /* #define HAL_DMA2D_MODULE_ENABLED */
00048 /* #define HAL_ETH_MODULE_ENABLED */
00049 /* #define HAL_ETH_LEGACY_MODULE_ENABLED */
00050 /* #define HAL_NAND_MODULE_ENABLED */
00051 /* #define HAL_NOR_MODULE_ENABLED */
00052 /* #define HAL_SRAM_MODULE_ENABLED */
00053 /* #define HAL_SDRAM_MODULE_ENABLED */
00054 /* #define HAL_HASH_MODULE_ENABLED */
00055 /* #define HAL_I2S_MODULE_ENABLED */
00056 /* #define HAL_IWDG_MODULE_ENABLED */
00057 /* #define HAL_LPTIM_MODULE_ENABLED */
00058 /* #define HAL_LTDC_MODULE_ENABLED */
00059 /* #define HAL_QSPI_MODULE_ENABLED */
00060 /* #define HAL_RNG_MODULE_ENABLED */
00061 /* #define HAL_RTC_MODULE_ENABLED */
00062 /* #define HAL_SAI_MODULE_ENABLED */
00063 /* #define HAL_SD_MODULE_ENABLED */
00064 /* #define HAL_MMC_MODULE_ENABLED */
00065 /* #define HAL_SPDIFRX_MODULE_ENABLED */
00066 /* #define HAL_SPI_MODULE_ENABLED */
00067 #define HAL_TIM_MODULE_ENABLED
00068 /* #define HAL_UART_MODULE_ENABLED */
00069 /* #define HAL_USART_MODULE_ENABLED */
00070 /* #define HAL_IRDA_MODULE_ENABLED */
00071 /* #define HAL_SMARTCARD_MODULE_ENABLED */
00072 /* #define HAL_WWDG_MODULE_ENABLED */
00073 /* #define HAL_PCD_MODULE_ENABLED */
00074 /* #define HAL_HCD_MODULE_ENABLED */
00075 /* #define HAL_DFSDM_MODULE_ENABLED */
00076 /* #define HAL_DSI_MODULE_ENABLED */
00077 /* #define HAL_JPEG_MODULE_ENABLED */
00078 /* #define HAL_MDIOS_MODULE_ENABLED */
00079 /* #define HAL_SMBUS_MODULE_ENABLED */
00080 /* #define HAL_EXTI_MODULE_ENABLED */
```

```

00081 #define HAL_GPIO_MODULE_ENABLED
00082 #define HAL_EXTI_MODULE_ENABLED
00083 #define HAL_DMA_MODULE_ENABLED
00084 #define HAL_RCC_MODULE_ENABLED
00085 #define HAL_FLASH_MODULE_ENABLED
00086 #define HAL_PWR_MODULE_ENABLED
00087 #define HAL_I2C_MODULE_ENABLED
00088 #define HAL_CORTEX_MODULE_ENABLED
00089
00090 /* ##### HSE/HSI Values adaptation ##### */
00096 #if !defined (HSE_VALUE)
00097 #define HSE_VALUE ((uint32_t)20000000U)
00098 #endif /* HSE_VALUE */
00099
00100 #if !defined (HSE_STARTUP_TIMEOUT)
00101 #define HSE_STARTUP_TIMEOUT ((uint32_t)100U)
00102 #endif /* HSE_STARTUP_TIMEOUT */
00103
00109 #if !defined (HSI_VALUE)
00110 #define HSI_VALUE ((uint32_t)16000000U)
00111 #endif /* HSI_VALUE */
00112
00116 #if !defined (LSI_VALUE)
00117 #define LSI_VALUE ((uint32_t)32000U)
00118 #endif /* LSI_VALUE */
00124 #if !defined (LSE_VALUE)
00125 #define LSE_VALUE ((uint32_t)32768U)
00126 #endif /* LSE_VALUE */
00127
00128 #if !defined (LSE_STARTUP_TIMEOUT)
00129 #define LSE_STARTUP_TIMEOUT ((uint32_t)5000U)
00130 #endif /* LSE_STARTUP_TIMEOUT */
00131
00137 #if !defined (EXTERNAL_CLOCK_VALUE)
00138 #define EXTERNAL_CLOCK_VALUE ((uint32_t)12288000U)
00139 #endif /* EXTERNAL_CLOCK_VALUE */
00140
00141 /* Tip: To avoid modifying this file each time you need to use different HSE,
00142 === you can define the HSE value in your toolchain compiler preprocessor. */
00143
00144 /* ##### System Configuration ##### */
00148 #define VDD_VALUE 3300U
00149 #define TICK_INT_PRIORITY ((uint32_t)15U)
00150 #define USERTOS 0U
00151 #define PREFETCH_ENABLE 0U
00152 #define ART_ACCELERATOR_ENABLE 0U /* To enable instruction cache and prefetch */
00153
00154 #define USE_HAL_ADC_REGISTER_CALLBACKS 0U /* ADC register callback disabled */
00155 #define USE_HAL_CAN_REGISTER_CALLBACKS 0U /* CAN register callback disabled */
00156 #define USE_HAL_CEC_REGISTER_CALLBACKS 0U /* CEC register callback disabled */
00157 #define USE_HAL_CRYP_REGISTER_CALLBACKS 0U /* CRYP register callback disabled */
00158 #define USE_HAL_DAC_REGISTER_CALLBACKS 0U /* DAC register callback disabled */
00159 #define USE_HAL_DCMI_REGISTER_CALLBACKS 0U /* DCMI register callback disabled */
00160 #define USE_HAL_DFSDM_REGISTER_CALLBACKS 0U /* DFSDM register callback disabled */
00161 #define USE_HAL_DMA2D_REGISTER_CALLBACKS 0U /* DMA2D register callback disabled */
00162 #define USE_HAL_DSI_REGISTER_CALLBACKS 0U /* DSI register callback disabled */
00163 #define USE_HAL_ETH_REGISTER_CALLBACKS 0U /* ETH register callback disabled */
00164 #define USE_HAL_HASH_REGISTER_CALLBACKS 0U /* HASH register callback disabled */
00165 #define USE_HAL_HCD_REGISTER_CALLBACKS 0U /* HCD register callback disabled */
00166 #define USE_HAL_I2C_REGISTER_CALLBACKS 0U /* I2C register callback disabled */
00167 #define USE_HAL_I2S_REGISTER_CALLBACKS 0U /* I2S register callback disabled */
00168 #define USE_HAL_IRDA_REGISTER_CALLBACKS 0U /* IRDA register callback disabled */
00169 #define USE_HAL_JPEG_REGISTER_CALLBACKS 0U /* JPEG register callback disabled */
00170 #define USE_HAL_LPTIM_REGISTER_CALLBACKS 0U /* LPTIM register callback disabled */
00171 #define USE_HAL_LTDC_REGISTER_CALLBACKS 0U /* LTDC register callback disabled */
00172 #define USE_HAL_MDIOS_REGISTER_CALLBACKS 0U /* MDIOS register callback disabled */
00173 #define USE_HAL_MMCHOST_REGISTER_CALLBACKS 0U /* MMC register callback disabled */
00174 #define USE_HAL_NAND_REGISTER_CALLBACKS 0U /* NAND register callback disabled */
00175 #define USE_HAL_NOR_REGISTER_CALLBACKS 0U /* NOR register callback disabled */
00176 #define USE_HAL_PCD_REGISTER_CALLBACKS 0U /* PCD register callback disabled */
00177 #define USE_HAL_QSPI_REGISTER_CALLBACKS 0U /* QSPI register callback disabled */
00178 #define USE_HAL_RNG_REGISTER_CALLBACKS 0U /* RNG register callback disabled */
00179 #define USE_HAL_RTC_REGISTER_CALLBACKS 0U /* RTC register callback disabled */
00180 #define USE_HAL_SAI_REGISTER_CALLBACKS 0U /* SAI register callback disabled */
00181 #define USE_HAL_SD_REGISTER_CALLBACKS 0U /* SD register callback disabled */
00182 #define USE_HAL_SMARTCARD_REGISTER_CALLBACKS 0U /* SMARTCARD register callback disabled */
00183 #define USE_HAL_SDRAM_REGISTER_CALLBACKS 0U /* SDRAM register callback disabled */
00184 #define USE_HAL_SRAM_REGISTER_CALLBACKS 0U /* SRAM register callback disabled */
00185 #define USE_HAL_SPDIFRX_REGISTER_CALLBACKS 0U /* SPDIFRX register callback disabled */
00186 #define USE_HAL_SMBUS_REGISTER_CALLBACKS 0U /* SMBUS register callback disabled */
00187 #define USE_HAL_SPI_REGISTER_CALLBACKS 0U /* SPI register callback disabled */
00188 #define USE_HAL_TIM_REGISTER_CALLBACKS 0U /* TIM register callback disabled */
00189 #define USE_HAL_UART_REGISTER_CALLBACKS 0U /* UART register callback disabled */
00190 #define USE_HAL_USART_REGISTER_CALLBACKS 0U /* USART register callback disabled */
00191 #define USE_HAL_WWDG_REGISTER_CALLBACKS 0U /* WWDG register callback disabled */
00192
00193 /* ##### Assert Selection ##### */

```

```

00198 /* #define USE_FULL_ASSERT      1U */
00199
00200 /* ##### Ethernet peripheral configuration ###### */
00201
00202 /* Section 1 : Ethernet peripheral configuration */
00203
00204 /* MAC ADDRESS: MAC_ADDR0:MAC_ADDR1:MAC_ADDR2:MAC_ADDR3:MAC_ADDR4:MAC_ADDR5 */
00205 #define MAC_ADDR0    2U
00206 #define MAC_ADDR1    0U
00207 #define MAC_ADDR2    0U
00208 #define MAC_ADDR3    0U
00209 #define MAC_ADDR4    0U
00210 #define MAC_ADDR5    0U
00211
00212 /* Definition of the Ethernet driver buffers size and count */
00213 #define ETH_RX_BUF_SIZE          ETH_MAX_PACKET_SIZE /* buffer size for receive           */
00214 #define ETH_TX_BUF_SIZE          ETH_MAX_PACKET_SIZE /* buffer size for transmit          */
00215 #define ETH_RXBUFNBN             ((uint32_t)4U)        /* 4 Rx buffers of size ETH_RX_BUF_SIZE
00216 #define ETH_TXBUFNBN             ((uint32_t)4U)        /* 4 Tx buffers of size ETH_TX_BUF_SIZE
00217
00218 /* Section 2: PHY configuration section */
00219
00220 /* DP83848_PHY_ADDRESS Address*/
00221 #define DP83848_PHY_ADDRESS
00222 /* PHY Reset delay these values are based on a 1 ms Systick interrupt*/
00223 #define PHY_RESET_DELAY          ((uint32_t)0x000000FFU)
00224 /* PHY Configuration delay */
00225 #define PHY_CONFIG_DELAY         ((uint32_t)0x000000FFU)
00226
00227 #define PHY_READ_TO              ((uint32_t)0x0000FFFFU)
00228 #define PHY_WRITE_TO              ((uint32_t)0x0000FFFFU)
00229
00230 /* Section 3: Common PHY Registers */
00231
00232 #define PHY_BCR                 ((uint16_t)0x0000U)
00233 #define PHY_BSR                 ((uint16_t)0x0001U)
00235 #define PHY_RESET                ((uint16_t)0x8000U)
00236 #define PHY_LOOPBACK              ((uint16_t)0x4000U)
00237 #define PHY_FULLDUPLEX_100M       ((uint16_t)0x2100U)
00238 #define PHY_HALFDUPLEX_100M       ((uint16_t)0x2000U)
00239 #define PHY_FULLDUPLEX_10M        ((uint16_t)0x0100U)
00240 #define PHY_HALFDUPLEX_10M        ((uint16_t)0x0000U)
00241 #define PHY_AUTONEGOTIATION       ((uint16_t)0x1000U)
00242 #define PHY_RESTART_AUTONEGO       ((uint16_t)0x0200U)
00243 #define PHY_POWERDOWN              ((uint16_t)0x0800U)
00244 #define PHY_ISOLATE               ((uint16_t)0x0400U)
00246 #define PHY_AUTONEGO_COMPLETE     ((uint16_t)0x0020U)
00247 #define PHY_LINKED_STATUS         ((uint16_t)0x0004U)
00248 #define PHY_JABBER_DETECTION      ((uint16_t)0x0002U)
00250 /* Section 4: Extended PHY Registers */
00251 #define PHY_SR                  ((uint16_t))
00253 #define PHY_SPEED_STATUS          ((uint16_t))
00254 #define PHY_DUPLEX_STATUS         ((uint16_t))
00256 /* ##### SPI peripheral configuration ###### */
00257
00258 /* CRC FEATURE: Use to activate CRC feature inside HAL SPI Driver
00259 * Activated: CRC code is present inside driver
00260 * Deactivated: CRC code cleaned from driver
00261 */
00262
00263 #define USE_SPI_CRC              0U
00264
00265 /* Includes -----*/
00270 #ifdef HAL_RCC_MODULE_ENABLED
00271   #include "stm32f7xx_hal_rcc.h"
00272 #endif /* HAL_RCC_MODULE_ENABLED */
00273
00274 #ifdef HAL_EXTI_MODULE_ENABLED
00275   #include "stm32f7xx_hal_exti.h"
00276 #endif /* HAL_EXTI_MODULE_ENABLED */
00277
00278 #ifdef HAL_GPIO_MODULE_ENABLED
00279   #include "stm32f7xx_hal_gpio.h"
00280 #endif /* HAL_GPIO_MODULE_ENABLED */
00281
00282 #ifdef HAL_DMA_MODULE_ENABLED
00283   #include "stm32f7xx_hal_dma.h"
00284 #endif /* HAL_DMA_MODULE_ENABLED */
00285
00286 #ifdef HAL_CORTEX_MODULE_ENABLED
00287   #include "stm32f7xx_hal_cortex.h"
00288 #endif /* HAL_CORTEX_MODULE_ENABLED */
00289
00290 #ifdef HAL_ADC_MODULE_ENABLED
00291   #include "stm32f7xx_hal_adc.h"

```

```
00292 #endif /* HAL_ADC_MODULE_ENABLED */
00293
00294 #ifdef HAL_CAN_MODULE_ENABLED
00295     #include "stm32f7xx_hal_can.h"
00296 #endif /* HAL_CAN_MODULE_ENABLED */
00297
00298 #ifdef HAL_CEC_MODULE_ENABLED
00299     #include "stm32f7xx_hal_cec.h"
00300 #endif /* HAL_CEC_MODULE_ENABLED */
00301
00302 #ifdef HAL_CRC_MODULE_ENABLED
00303     #include "stm32f7xx_hal_crc.h"
00304 #endif /* HAL_CRC_MODULE_ENABLED */
00305
00306 #ifdef HAL_CRYP_MODULE_ENABLED
00307     #include "stm32f7xx_hal_cryp.h"
00308 #endif /* HAL_CRYP_MODULE_ENABLED */
00309
00310 #ifdef HAL_DMA2D_MODULE_ENABLED
00311     #include "stm32f7xx_hal_dma2d.h"
00312 #endif /* HAL_DMA2D_MODULE_ENABLED */
00313
00314 #ifdef HAL_DAC_MODULE_ENABLED
00315     #include "stm32f7xx_hal_dac.h"
00316 #endif /* HAL_DAC_MODULE_ENABLED */
00317
00318 #ifdef HAL_DCMI_MODULE_ENABLED
00319     #include "stm32f7xx_hal_dcmi.h"
00320 #endif /* HAL_DCMI_MODULE_ENABLED */
00321
00322 #ifdef HAL_ETH_MODULE_ENABLED
00323     #include "stm32f7xx_hal_eth.h"
00324 #endif /* HAL_ETH_MODULE_ENABLED */
00325
00326 #ifdef HAL_ETH_LEGACY_MODULE_ENABLED
00327     #include "stm32f7xx_hal_eth_legacy.h"
00328 #endif /* HAL_ETH_LEGACY_MODULE_ENABLED */
00329
00330 #ifdef HAL_FLASH_MODULE_ENABLED
00331     #include "stm32f7xx_hal_flash.h"
00332 #endif /* HAL_FLASH_MODULE_ENABLED */
00333
00334 #ifdef HAL_SRAM_MODULE_ENABLED
00335     #include "stm32f7xx_hal_sram.h"
00336 #endif /* HAL_SRAM_MODULE_ENABLED */
00337
00338 #ifdef HAL_NOR_MODULE_ENABLED
00339     #include "stm32f7xx_hal_nor.h"
00340 #endif /* HAL_NOR_MODULE_ENABLED */
00341
00342 #ifdef HAL_NAND_MODULE_ENABLED
00343     #include "stm32f7xx_hal_nand.h"
00344 #endif /* HAL_NAND_MODULE_ENABLED */
00345
00346 #ifdef HAL_SDRAM_MODULE_ENABLED
00347     #include "stm32f7xx_hal_sdram.h"
00348 #endif /* HAL_SDRAM_MODULE_ENABLED */
00349
00350 #ifdef HAL_HASH_MODULE_ENABLED
00351     #include "stm32f7xx_hal_hash.h"
00352 #endif /* HAL_HASH_MODULE_ENABLED */
00353
00354 #ifdef HAL_I2C_MODULE_ENABLED
00355     #include "stm32f7xx_hal_i2c.h"
00356 #endif /* HAL_I2C_MODULE_ENABLED */
00357
00358 #ifdef HAL_I2S_MODULE_ENABLED
00359     #include "stm32f7xx_hal_i2s.h"
00360 #endif /* HAL_I2S_MODULE_ENABLED */
00361
00362 #ifdef HAL_IWDG_MODULE_ENABLED
00363     #include "stm32f7xx_hal_iwdg.h"
00364 #endif /* HAL_IWDG_MODULE_ENABLED */
00365
00366 #ifdef HAL_LPTIM_MODULE_ENABLED
00367     #include "stm32f7xx_hal_lptim.h"
00368 #endif /* HAL_LPTIM_MODULE_ENABLED */
00369
00370 #ifdef HAL_LTDC_MODULE_ENABLED
00371     #include "stm32f7xx_hal_ltddc.h"
00372 #endif /* HAL_LTDC_MODULE_ENABLED */
00373
00374 #ifdef HAL_PWR_MODULE_ENABLED
00375     #include "stm32f7xx_hal_pwr.h"
00376 #endif /* HAL_PWR_MODULE_ENABLED */
00377
00378 #ifdef HAL_QSPI_MODULE_ENABLED
```

```

00379 #include "stm32f7xx_hal_qspi.h"
00380 #endif /* HAL_QSPI_MODULE_ENABLED */
00381
00382 #ifdef HAL_RNG_MODULE_ENABLED
00383 #include "stm32f7xx_hal_rng.h"
00384 #endif /* HAL_RNG_MODULE_ENABLED */
00385
00386 #ifdef HAL_RTC_MODULE_ENABLED
00387 #include "stm32f7xx_hal_rtc.h"
00388 #endif /* HAL_RTC_MODULE_ENABLED */
00389
00390 #ifdef HAL_SAI_MODULE_ENABLED
00391 #include "stm32f7xx_hal_sai.h"
00392 #endif /* HAL_SAI_MODULE_ENABLED */
00393
00394 #ifdef HAL_SD_MODULE_ENABLED
00395 #include "stm32f7xx_hal_sd.h"
00396 #endif /* HAL_SD_MODULE_ENABLED */
00397
00398 #ifdef HAL_MMC_MODULE_ENABLED
00399 #include "stm32f7xx_hal_mmc.h"
00400 #endif /* HAL_MMC_MODULE_ENABLED */
00401
00402 #ifdef HAL_SPDIFRX_MODULE_ENABLED
00403 #include "stm32f7xx_hal_spdifrx.h"
00404 #endif /* HAL_SPDIFRX_MODULE_ENABLED */
00405
00406 #ifdef HAL_SPI_MODULE_ENABLED
00407 #include "stm32f7xx_hal_spi.h"
00408 #endif /* HAL_SPI_MODULE_ENABLED */
00409
00410 #ifdef HAL_TIM_MODULE_ENABLED
00411 #include "stm32f7xx_hal_tim.h"
00412 #endif /* HAL_TIM_MODULE_ENABLED */
00413
00414 #ifdef HAL_UART_MODULE_ENABLED
00415 #include "stm32f7xx_hal_uart.h"
00416 #endif /* HAL_UART_MODULE_ENABLED */
00417
00418 #ifdef HAL_USART_MODULE_ENABLED
00419 #include "stm32f7xx_hal_usart.h"
00420 #endif /* HAL_USART_MODULE_ENABLED */
00421
00422 #ifdef HAL_IRDA_MODULE_ENABLED
00423 #include "stm32f7xx_hal_irda.h"
00424 #endif /* HAL_IRDA_MODULE_ENABLED */
00425
00426 #ifdef HAL_SMARTCARD_MODULE_ENABLED
00427 #include "stm32f7xx_hal_smartcard.h"
00428 #endif /* HAL_SMARTCARD_MODULE_ENABLED */
00429
00430 #ifdef HAL_WWDG_MODULE_ENABLED
00431 #include "stm32f7xx_hal_wwdg.h"
00432 #endif /* HAL_WWDG_MODULE_ENABLED */
00433
00434 #ifdef HAL_PCD_MODULE_ENABLED
00435 #include "stm32f7xx_hal_pcd.h"
00436 #endif /* HAL_PCD_MODULE_ENABLED */
00437
00438 #ifdef HAL_HCD_MODULE_ENABLED
00439 #include "stm32f7xx_hal_hcd.h"
00440 #endif /* HAL_HCD_MODULE_ENABLED */
00441
00442 #ifdef HAL_DFSDM_MODULE_ENABLED
00443 #include "stm32f7xx_hal_dfsm.h"
00444 #endif /* HAL_DFSDM_MODULE_ENABLED */
00445
00446 #ifdef HAL_DSI_MODULE_ENABLED
00447 #include "stm32f7xx_hal_dsi.h"
00448 #endif /* HAL_DSI_MODULE_ENABLED */
00449
00450 #ifdef HAL_JPEG_MODULE_ENABLED
00451 #include "stm32f7xx_hal_jpeg.h"
00452 #endif /* HAL_JPEG_MODULE_ENABLED */
00453
00454 #ifdef HAL_MDIOS_MODULE_ENABLED
00455 #include "stm32f7xx_hal_mdios.h"
00456 #endif /* HAL_MDIOS_MODULE_ENABLED */
00457
00458 #ifdef HAL_SMBUS_MODULE_ENABLED
00459 #include "stm32f7xx_hal_smbus.h"
00460 #endif /* HAL_SMBUS_MODULE_ENABLED */
00461
00462 /* Exported macro -----*/
00463 #ifdef USE_FULL_ASSERT
00464 #define assert_param(expr) ((expr) ? (void)0U : assert_failed((uint8_t *)__FILE__, __LINE__))
00465 /* Exported functions ----- */

```

```

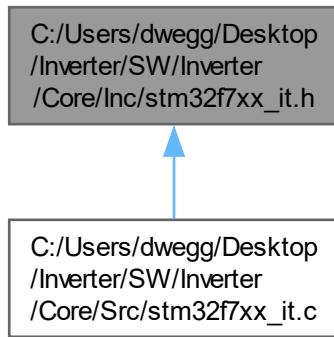
00474     void assert_failed(uint8_t* file, uint32_t line);
00475 #else
00476     #define assert_param(expr) ((void)0U)
00477 #endif /* USE_FULL_ASSERT */
00478
00479 #ifdef __cplusplus
00480 }
00481 #endif
00482
00483 #endif /* __STM32F7XX_HAL_CONF_H */
00484

```

6.35 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/stm32f7xx_it.h File Reference

This file contains the headers of the interrupt handlers.

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



Functions

- void **NMI_Handler** (void)
This function handles Non maskable interrupt.
- void **HardFault_Handler** (void)
This function handles Hard fault interrupt.
- void **MemManage_Handler** (void)
This function handles Memory management fault.
- void **BusFault_Handler** (void)
This function handles Pre-fetch fault, memory access fault.
- void **UsageFault_Handler** (void)
This function handles Undefined instruction or illegal state.
- void **SVC_Handler** (void)
This function handles System service call via SWI instruction.
- void **DebugMon_Handler** (void)
This function handles Debug monitor.
- void **PendSV_Handler** (void)

- void [SysTick_Handler](#) (void)
This function handles Pendable request for system service.
- void [CAN1_RX0_IRQHandler](#) (void)
This function handles System tick timer.
- void [TIM1_UP_TIM10_IRQHandler](#) (void)
This function handles CAN1 RX0 interrupts.
- void [TIM6_DAC_IRQHandler](#) (void)
This function handles TIM1 update interrupt and TIM10 global interrupt.
- void [DMA2_Stream0_IRQHandler](#) (void)
This function handles TIM6 global interrupt, DAC1 and DAC2 underrun error interrupts.
- void [DMA2_Stream1_IRQHandler](#) (void)
This function handles DMA2 stream0 global interrupt.
- void [DMA2_Stream2_IRQHandler](#) (void)
This function handles DMA2 stream1 global interrupt.
- void [DMA2_Stream3_IRQHandler](#) (void)
This function handles DMA2 stream2 global interrupt.

6.35.1 Detailed Description

This file contains the headers of the interrupt handlers.

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6.35.2 Function Documentation

6.35.2.1 BusFault_Handler()

```
void BusFault_Handler (
    void )
```

This function handles Pre-fetch fault, memory access fault.

6.35.2.2 CAN1_RX0_IRQHandler()

```
void CAN1_RX0_IRQHandler (
    void )
```

This function handles CAN1 RX0 interrupts.

6.35.2.3 DebugMon_Handler()

```
void DebugMon_Handler (
    void )
```

This function handles Debug monitor.

6.35.2.4 DMA2_Stream0_IRQHandler()

```
void DMA2_Stream0_IRQHandler (
    void )
```

This function handles DMA2 stream0 global interrupt.

6.35.2.5 DMA2_Stream1_IRQHandler()

```
void DMA2_Stream1_IRQHandler (
    void )
```

This function handles DMA2 stream1 global interrupt.

6.35.2.6 DMA2_Stream2_IRQHandler()

```
void DMA2_Stream2_IRQHandler (
    void )
```

This function handles DMA2 stream2 global interrupt.

6.35.2.7 HardFault_Handler()

```
void HardFault_Handler (
    void )
```

This function handles Hard fault interrupt.

6.35.2.8 MemManage_Handler()

```
void MemManage_Handler (
    void )
```

This function handles Memory management fault.

6.35.2.9 NMI_Handler()

```
void NMI_Handler (
    void )
```

This function handles Non maskable interrupt.

6.35.2.10 PendSV_Handler()

```
void PendSV_Handler (
    void )
```

This function handles Pendable request for system service.

6.35.2.11 SVC_Handler()

```
void SVC_Handler (
    void )
```

This function handles System service call via SWI instruction.

6.35.2.12 SysTick_Handler()

```
void SysTick_Handler (
    void )
```

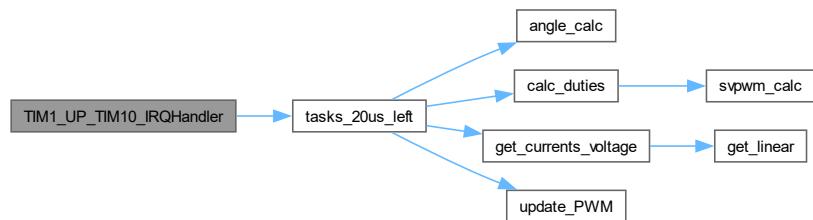
This function handles System tick timer.

6.35.2.13 TIM1_UP_TIM10_IRQHandler()

```
void TIM1_UP_TIM10_IRQHandler (
    void )
```

This function handles TIM1 update interrupt and TIM10 global interrupt.

Here is the call graph for this function:

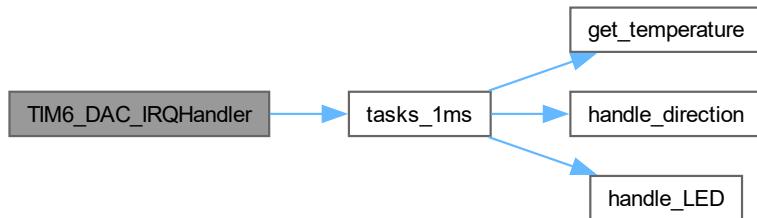


6.35.2.14 TIM6_DAC_IRQHandler()

```
void TIM6_DAC_IRQHandler (
    void )
```

This function handles TIM6 global interrupt, DAC1 and DAC2 underrun error interrupts.

Here is the call graph for this function:



6.35.2.15 UsageFault_Handler()

```
void UsageFault_Handler (
    void )
```

This function handles Undefined instruction or illegal state.

6.36 stm32f7xx_it.h

[Go to the documentation of this file.](#)

```
00001 /* USER CODE BEGIN Header */
00018 /* USER CODE END Header */
00019
00020 /* Define to prevent recursive inclusion -----*/
00021 #ifndef __STM32F7XX_IT_H
00022 #define __STM32F7XX_IT_H
00023
00024 #ifdef __cplusplus
00025   extern "C" {
00026 #endif
00027
00028 /* Private includes -----*/
00029 /* USER CODE BEGIN Includes */
00030
00031 /* USER CODE END Includes */
00032
00033 /* Exported types -----*/
00034 /* USER CODE BEGIN ET */
00035
00036 /* USER CODE END ET */
00037
00038 /* Exported constants -----*/
00039 /* USER CODE BEGIN EC */
00040
00041 /* USER CODE END EC */
00042
00043 /* Exported macro -----*/
00044 /* USER CODE BEGIN EM */
00045
```

```

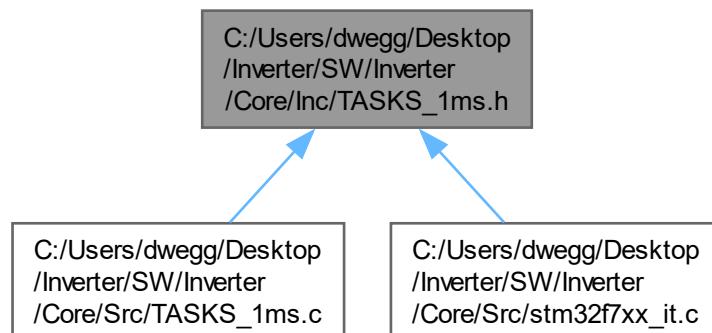
00046 /* USER CODE END EM */
00047
00048 /* Exported functions prototypes -----*/
00049 void NMI_Handler(void);
00050 void HardFault_Handler(void);
00051 void MemManage_Handler(void);
00052 void BusFault_Handler(void);
00053 void UsageFault_Handler(void);
00054 void SVC_Handler(void);
00055 void DebugMon_Handler(void);
00056 void PendSV_Handler(void);
00057 void SysTick_Handler(void);
00058 void CAN1_RX0_IRQHandler(void);
00059 void TIM1_UP_TIM10_IRQHandler(void);
00060 void TIM6_DAC_IRQHandler(void);
00061 void DMA2_Stream0_IRQHandler(void);
00062 void DMA2_Stream1_IRQHandler(void);
00063 void DMA2_Stream2_IRQHandler(void);
00064 /* USER CODE BEGIN EFP */
00065
00066 /* USER CODE END EFP */
00067
00068 #ifdef __cplusplus
00069 }
00070#endif
00071
00072#endif /* __STM32F7xx_IT_H */

```

6.37 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/TASKS_1ms.h File Reference

Header file for functions related to tasks executed every 1ms.

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



Functions

- void `tasks_1ms` (void)
Function to be executed every 1ms.

6.37.1 Detailed Description

Header file for functions related to tasks executed every 1ms.

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6.37.2 Function Documentation

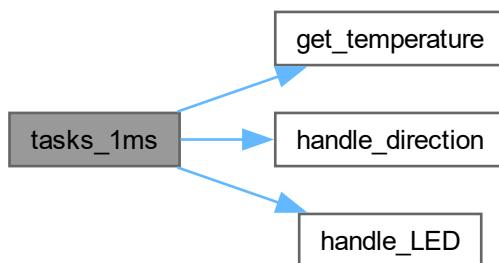
6.37.2.1 tasks_1ms()

```
void tasks_1ms (
    void )
```

Function to be executed every 1ms.

This function is called by the TIM6 IRQ handler every millisecond.

This function is called by the TIM6 IRQ handler every millisecond. It increments the millisecond counter and executes all the low priority tasks. Here is the call graph for this function:



Here is the caller graph for this function:



6.38 TASKS_1ms.h

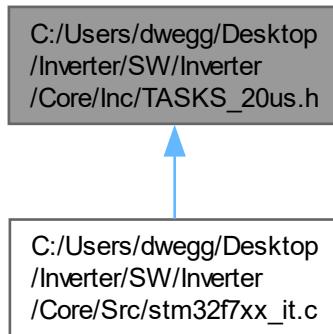
[Go to the documentation of this file.](#)

```
00001 /* USER CODE BEGIN Header */
00018 /* USER CODE END Header */
00019
00020
00021 #ifndef TASKS_1MS_H
00022 #define TASKS_1MS_H
00023
00029 void tasks_1ms(void);
00030
00031 #endif /* TASKS_1MS_H */
```

6.39 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/TASKS_20us.h File Reference

Header file for functions related to tasks executed every 20us in each PWM timer interruption.

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



Functions

- void [tasks_20us_left \(\)](#)
Function to be executed every TS.
- void [tasks_20us_right \(\)](#)
Function to be executed every TS.

6.39.1 Detailed Description

Header file for functions related to tasks executed every 20us in each PWM timer interruption.

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6.39.2 Function Documentation

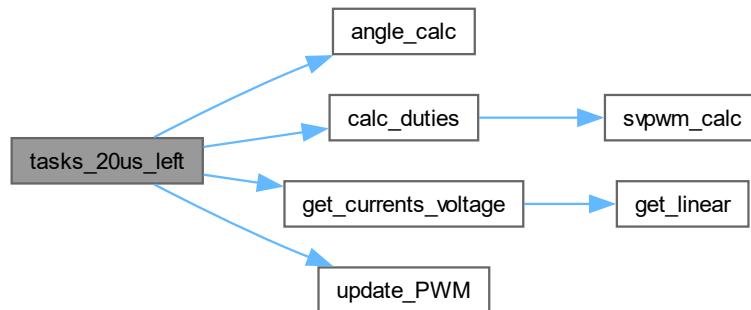
6.39.2.1 tasks_20us_left()

```
void tasks_20us_left (
    void )
```

Function to be executed every TS.

This function is called by the TIM1 trigger out handler every TS.

This function is called by the TIM1 trigger handler every TS. Here is the call graph for this function:



Here is the caller graph for this function:



6.39.2.2 tasks_20us_right()

```
void tasks_20us_right (
    void )
```

Function to be executed every TS.

This function is called by the TIM8 trigger out handler every TS.

This function is called by the TIM8 trigger handler every TS.

6.40 TASKS_20us.h

[Go to the documentation of this file.](#)

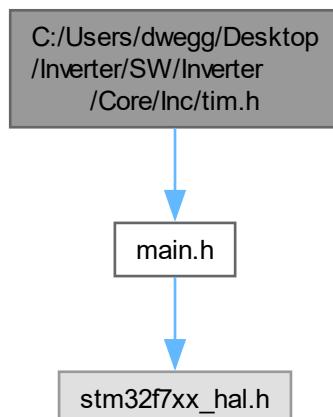
```
00001 /* USER CODE BEGIN Header */
00018 /* USER CODE END Header */
00019
00025 void tasks_20us_left();
00026
00032 void tasks_20us_right();
```

6.41 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/tim.h File Reference

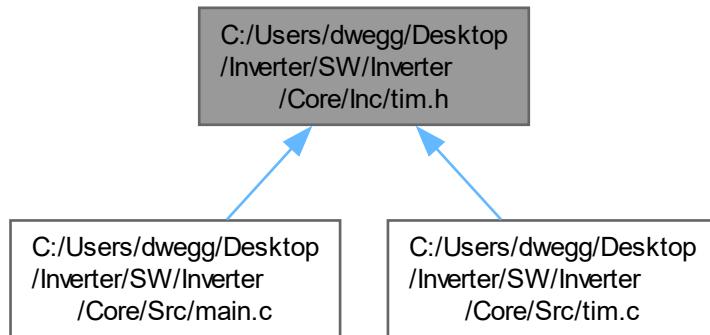
This file contains all the function prototypes for the [tim.c](#) file.

```
#include "main.h"
```

Include dependency graph for tim.h:



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



Functions

- void [MX_TIM1_Init](#) (void)
- void [MX_TIM2_Init](#) (void)
- void [MX_TIM4_Init](#) (void)
- void [MX_TIM6_Init](#) (void)
- void [MX_TIM8_Init](#) (void)
- void [HAL_TIM_MspPostInit](#) (TIM_HandleTypeDef *htim)

Variables

- TIM_HandleTypeDef [htim1](#)
- TIM_HandleTypeDef [htim2](#)
- TIM_HandleTypeDef [htim4](#)
- TIM_HandleTypeDef [htim6](#)
- TIM_HandleTypeDef [htim8](#)

6.41.1 Detailed Description

This file contains all the function prototypes for the [tim.c](#) file.

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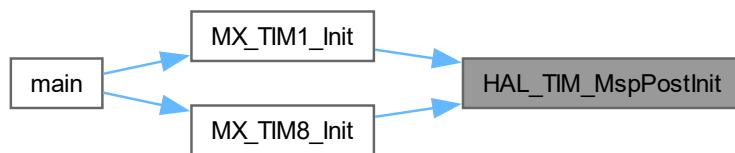
6.41.2 Function Documentation

6.41.2.1 HAL_TIM_MspPostInit()

```
void HAL_TIM_MspPostInit (
    TIM_HandleTypeDef * htim )
```

TIM1 GPIO Configuration PE8 -----> TIM1_CH1N PE9 -----> TIM1_CH1 PE10 -----> TIM1_CH2N PE11 ----->
TIM1_CH2 PE12 -----> TIM1_CH3N PE13 -----> TIM1_CH3

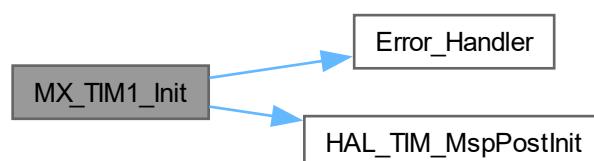
TIM8 GPIO Configuration PA5 -----> TIM8_CH1N PB14 -----> TIM8_CH2N PB15 -----> TIM8_CH3N PC6 ----->
TIM8_CH1 PC7 -----> TIM8_CH2 PC8 -----> TIM8_CH3Here is the caller graph for this function:



6.41.2.2 MX_TIM1_Init()

```
void MX_TIM1_Init (
    void )
```

Here is the call graph for this function:



Here is the caller graph for this function:



6.41.2.3 MX_TIM2_Init()

```
void MX_TIM2_Init (
    void )
```

Here is the call graph for this function:



Here is the caller graph for this function:



6.41.2.4 MX_TIM4_Init()

```
void MX_TIM4_Init (
    void )
```

Here is the call graph for this function:



Here is the caller graph for this function:



6.41.2.5 MX_TIM6_Init()

```
void MX_TIM6_Init (
    void )
```

Here is the call graph for this function:



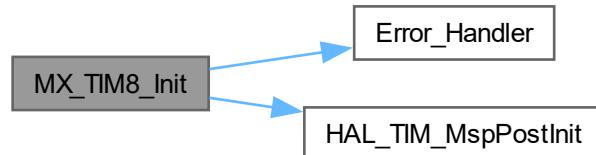
Here is the caller graph for this function:



6.41.2.6 MX_TIM8_Init()

```
void MX_TIM8_Init (
    void )
```

Here is the call graph for this function:



Here is the caller graph for this function:



6.41.3 Variable Documentation

6.41.3.1 htim1

```
TIM_HandleTypeDef htim1 [extern]
```

6.41.3.2 htim2

```
TIM_HandleTypeDef htim2 [extern]
```

6.41.3.3 htim4

```
TIM_HandleTypeDef htim4 [extern]
```

6.41.3.4 htim6

```
TIM_HandleTypeDef htim6 [extern]
```

6.41.3.5 htim8

```
TIM_HandleTypeDef htim8 [extern]
```

6.42 tim.h

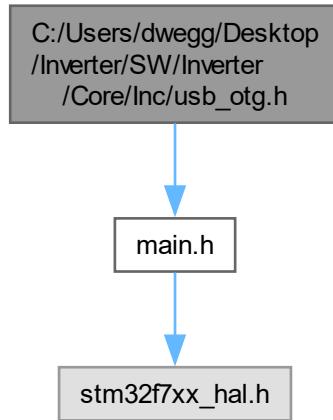
[Go to the documentation of this file.](#)

```
00001 /* USER CODE BEGIN Header */
00019 /* USER CODE END Header */
00020 /* Define to prevent recursive inclusion -----*/
00021 #ifndef __TIM_H__
00022 #define __TIM_H__
00023
00024 #ifdef __cplusplus
00025 extern "C" {
00026 #endif
00027
00028 /* Includes -----*/
00029 #include "main.h"
00030
00031 /* USER CODE BEGIN Includes */
00032
00033 /* USER CODE END Includes */
00034
00035 extern TIM_HandleTypeDef htim1;
00036
00037 extern TIM_HandleTypeDef htim2;
00038
00039 extern TIM_HandleTypeDef htim4;
00040
00041 extern TIM_HandleTypeDef htim6;
00042
00043 extern TIM_HandleTypeDef htim8;
00044
00045 /* USER CODE BEGIN Private defines */
00046
00047 /* USER CODE END Private defines */
00048
00049 void MX_TIM1_Init(void);
00050 void MX_TIM2_Init(void);
00051 void MX_TIM4_Init(void);
00052 void MX_TIM6_Init(void);
00053 void MX_TIM8_Init(void);
00054
00055 void HAL_TIM_MspPostInit(TIM_HandleTypeDef *htim);
00056
00057 /* USER CODE BEGIN Prototypes */
00058
00059 /* USER CODE END Prototypes */
00060
00061 #ifdef __cplusplus
00062 }
00063 #endif
00064
00065 #endif /* __TIM_H__ */
00066
```

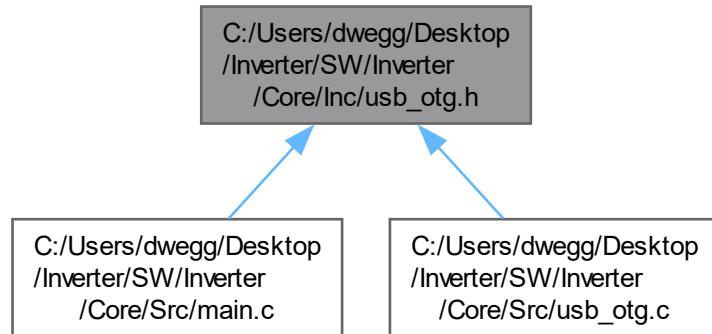
6.43 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Inc/usb_otg.h File Reference

This file contains all the function prototypes for the [usb_otg.c](#) file.

```
#include "main.h"
Include dependency graph for usb_otg.h:
```



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



Functions

- void [MX_USB_OTG_FS_USB_Init](#) (void)

6.43.1 Detailed Description

This file contains all the function prototypes for the [usb_otg.c](#) file.

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6.43.2 Function Documentation

6.43.2.1 MX_USB_OTG_FS_USB_Init()

```
void MX_USB_OTG_FS_USB_Init (
    void )
```

Here is the caller graph for this function:



6.44 usb_otg.h

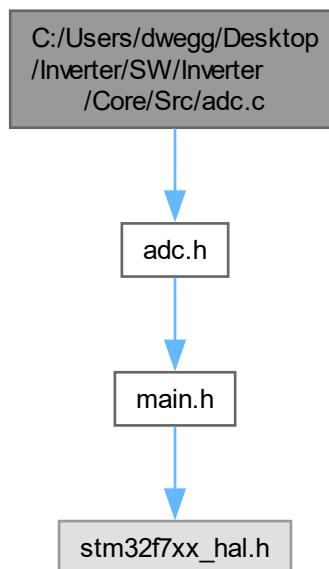
[Go to the documentation of this file.](#)

```
00001 /* USER CODE BEGIN Header */
00019 /* USER CODE END Header */
00020 /* Define to prevent recursive inclusion -----*/
00021 #ifndef __USB_OTG_H__
00022 #define __USB_OTG_H__
00023
00024 #ifdef __cplusplus
00025 extern "C" {
00026 #endif
00027
00028 /* Includes -----*/
00029 #include "main.h"
00030
00031 /* USER CODE BEGIN Includes */
00032
00033 /* USER CODE END Includes */
00034
00035 /* USER CODE BEGIN Private defines */
00036
00037 /* USER CODE END Private defines */
00038
00039 void MX_USB_OTG_FS_USB_Init(void);
00040
00041 /* USER CODE BEGIN Prototypes */
00042
00043 /* USER CODE END Prototypes */
00044
00045 #ifdef __cplusplus
00046 }
00047 #endif
00048
00049 #endif /* __USB_OTG_H__ */
00050
```

6.45 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/adc.c File Reference

This file provides code for the configuration of the ADC instances.

```
#include "adc.h"  
Include dependency graph for adc.c:
```



Functions

- void [MX_ADC1_Init](#) (void)
- void [MX_ADC2_Init](#) (void)
- void [MX_ADC3_Init](#) (void)
- void [HAL_ADC_MspInit](#) (ADC_HandleTypeDef *adcHandle)
- void [HAL_ADC_MspDeInit](#) (ADC_HandleTypeDef *adcHandle)

Variables

- ADC_HandleTypeDef [hadc1](#)
- ADC_HandleTypeDef [hadc2](#)
- ADC_HandleTypeDef [hadc3](#)
- DMA_HandleTypeDef [hdma_adc1](#)
- DMA_HandleTypeDef [hdma_adc2](#)
- DMA_HandleTypeDef [hdma_adc3](#)

6.45.1 Detailed Description

This file provides code for the configuration of the ADC instances.

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6.45.2 Function Documentation

6.45.2.1 HAL_ADC_MspDeInit()

```
void HAL_ADC_MspDeInit (
    ADC_HandleTypeDef * adcHandle )
```

ADC1 GPIO Configuration PA0/WKUP -----> ADC1_IN0 PA1 -----> ADC1_IN1 PA2 -----> ADC1_IN2 PA3 -----> ADC1_IN3

ADC2 GPIO Configuration PA6 -----> ADC2_IN6 PA7 -----> ADC2_IN7 PB0 -----> ADC2_IN8 PB1 -----> ADC2_IN9

ADC3 GPIO Configuration PC0 -----> ADC3_IN10 PC1 -----> ADC3_IN11 PC2 -----> ADC3_IN12 PC3 -----> ADC3_IN13

6.45.2.2 HAL_ADC_MspInit()

```
void HAL_ADC_MspInit (
    ADC_HandleTypeDef * adcHandle )
```

ADC1 GPIO Configuration PA0/WKUP -----> ADC1_IN0 PA1 -----> ADC1_IN1 PA2 -----> ADC1_IN2 PA3 -----> ADC1_IN3

ADC2 GPIO Configuration PA6 -----> ADC2_IN6 PA7 -----> ADC2_IN7 PB0 -----> ADC2_IN8 PB1 -----> ADC2_IN9

ADC3 GPIO Configuration PC0 -----> ADC3_IN10 PC1 -----> ADC3_IN11 PC2 -----> ADC3_IN12 PC3 -----> ADC3_IN13

Here is the call graph for this function:



6.45.2.3 MX_ADC1_Init()

```
void MX_ADC1_Init (
    void )
```

Configure the global features of the ADC (Clock, Resolution, Data Alignment and number of conversion)

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time. Here is the call graph for this function:



Here is the caller graph for this function:



6.45.2.4 MX_ADC2_Init()

```
void MX_ADC2_Init (
    void )
```

Configure the global features of the ADC (Clock, Resolution, Data Alignment and number of conversion)

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time. Here is the call graph for this function:



Here is the caller graph for this function:



6.45.2.5 MX_ADC3_Init()

```
void MX_ADC3_Init (
    void  )
```

Configure the global features of the ADC (Clock, Resolution, Data Alignment and number of conversion)

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time.

Configure for the selected ADC regular channel its corresponding rank in the sequencer and its sample time. Here is the call graph for this function:



Here is the caller graph for this function:



6.45.3 Variable Documentation

6.45.3.1 hadc1

```
ADC_HandleTypeDef hadc1
```

6.45.3.2 hadc2

```
ADC_HandleTypeDef hadc2
```

6.45.3.3 hadc3

```
ADC_HandleTypeDef hadc3
```

6.45.3.4 hdma_adc1

```
DMA_HandleTypeDef hdma_adc1
```

6.45.3.5 hdma_adc2

```
DMA_HandleTypeDef hdma_adc2
```

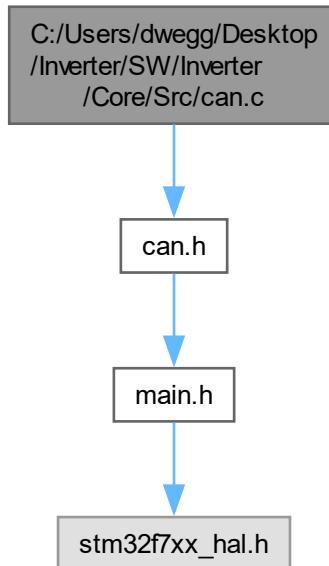
6.45.3.6 hdma_adc3

```
DMA_HandleTypeDef hdma_adc3
```

6.46 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/can.c File Reference

This file provides code for the configuration of the CAN instances.

```
#include "can.h"
Include dependency graph for can.c:
```



Functions

- void [MX_CAN1_Init](#) (void)
- void [HAL_CAN_MspInit](#) (CAN_HandleTypeDef *canHandle)
- void [HAL_CAN_MspDeInit](#) (CAN_HandleTypeDef *canHandle)

Variables

- CAN_HandleTypeDef [hcan1](#)

6.46.1 Detailed Description

This file provides code for the configuration of the CAN instances.

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6.46.2 Function Documentation

6.46.2.1 HAL_CAN_MspDeInit()

```
void HAL_CAN_MspDeInit (
    CAN_HandleTypeDef * canHandle )
```

CAN1 GPIO Configuration PD0 -----> CAN1_RX PD1 -----> CAN1_TX

6.46.2.2 HAL_CAN_MspInit()

```
void HAL_CAN_MspInit (
    CAN_HandleTypeDef * canHandle )
```

CAN1 GPIO Configuration PD0 -----> CAN1_RX PD1 -----> CAN1_TX

6.46.2.3 MX_CAN1_Init()

```
void MX_CAN1_Init (
    void )
```

Here is the call graph for this function:



Here is the caller graph for this function:



6.46.3 Variable Documentation

6.46.3.1 hcan1

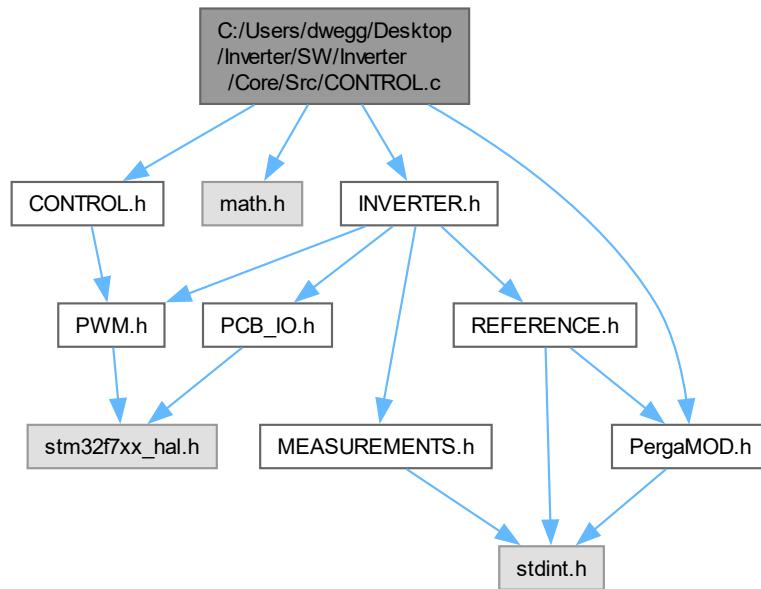
```
CAN_HandleTypeDef hcan1
```

6.47 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/CONTROL.c File Reference

This file provides code for the control loop.

```
#include "CONTROL.h"
#include <math.h>
#include <PergaMOD.h>
#include "INVERTER.h"
```

Include dependency graph for CONTROL.c:



Functions

- void `calc_duties` (float vd, float vq, float vDC, float theta_e, volatile `Duties` *duties)
function.

6.47.1 Detailed Description

This file provides code for the control loop.

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6.47.2 Function Documentation

6.47.2.1 calc_duties()

```
void calc_duties (
    float vd,
    float vq,
    float vDC,
    float theta_e,
    volatile Duties * duties )
```

function.

This function calculates the inverse Park transform and the duty cycles using SVPWM

Parameters

in	<i>vd</i>	Voltage in the d-axis.
in	<i>vq</i>	Voltage in the q-axis.
in	<i>vDC</i>	DC voltage.
in	<i>theta_e</i>	Electrical angle in radians (-pi..pi).
out	<i>duties</i>	Pointer to the duties structure.

Here is the call graph for this function:



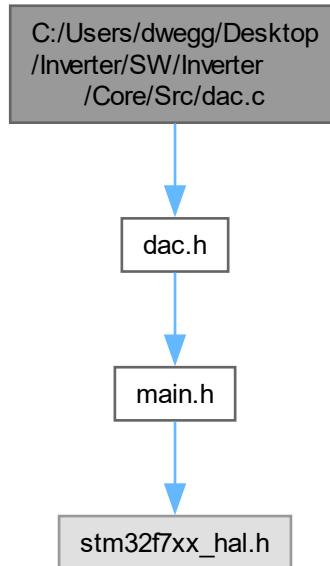
Here is the caller graph for this function:



6.48 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/dac.c File Reference

This file provides code for the configuration of the DAC instances.

```
#include "dac.h"
Include dependency graph for dac.c:
```



Functions

- void [MX_DAC_Init](#) (void)
- void [HAL_DAC_MspInit](#) (DAC_HandleTypeDef *dacHandle)
- void [HAL_DAC_MspDeInit](#) (DAC_HandleTypeDef *dacHandle)

Variables

- DAC_HandleTypeDef [hdac](#)

6.48.1 Detailed Description

This file provides code for the configuration of the DAC instances.

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6.48.2 Function Documentation

6.48.2.1 HAL_DAC_MspDeInit()

```
void HAL_DAC_MspDeInit (
    DAC_HandleTypeDef * dacHandle )
```

DAC GPIO Configuration PA4 -----> DAC_OUT1

Uncomment the line below to disable the "TIM6_DAC_IRQn" interrupt Be aware, disabling shared interrupt may affect other IPs

6.48.2.2 HAL_DAC_MspInit()

```
void HAL_DAC_MspInit (
    DAC_HandleTypeDef * dacHandle )
```

DAC GPIO Configuration PA4 -----> DAC_OUT1

6.48.2.3 MX_DAC_Init()

```
void MX_DAC_Init (
    void )
```

DAC Initialization

DAC channel OUT1 configHere is the call graph for this function:



Here is the caller graph for this function:



6.48.3 Variable Documentation

6.48.3.1 hdac

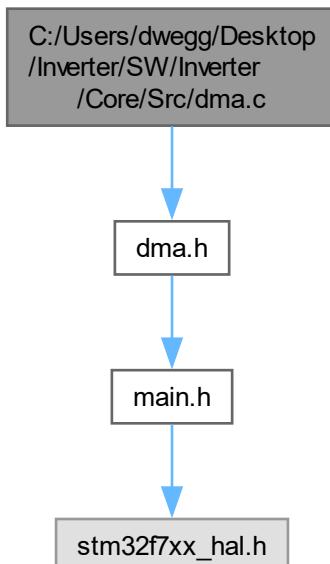
```
DAC_HandleTypeDef hdac
```

6.49 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/dma.c File Reference

This file provides code for the configuration of all the requested memory to memory DMA transfers.

```
#include "dma.h"
```

Include dependency graph for dma.c:



Functions

- void [MX_DMA_Init](#) (void)

6.49.1 Detailed Description

This file provides code for the configuration of all the requested memory to memory DMA transfers.

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6.49.2 Function Documentation

6.49.2.1 MX_DMA_Init()

```
void MX_DMA_Init (
    void )
```

Enable DMA controller clock Here is the caller graph for this function:

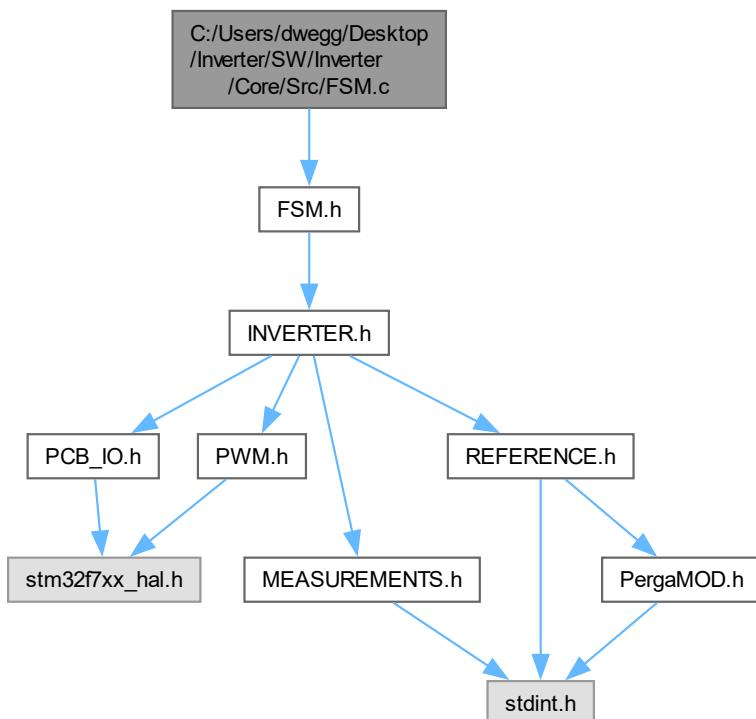


6.50 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/FSM.c File Reference

This file provides code for the inverter Finite State Machine.

```
#include "FSM.h"
```

Include dependency graph for FSM.c:



Functions

- void `eval_inv_FSM` (volatile `InverterStruct` *`inv`)

Execute the finite state machine for inverter.

6.50.1 Detailed Description

This file provides code for the inverter Finite State Machine.

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6.50.2 Function Documentation

6.50.2.1 eval_inv_FSM()

```
void eval_inv_FSM (
    volatile InverterStruct * inv )
```

Execute the finite state machine for inverter.

Run the Finite State Machine (FSM) for inverter operation control.

This function executes the finite state machine to control the inverter based on its current state.

Parameters

<code>inv</code>	Pointer to the inverter structure.
------------------	------------------------------------

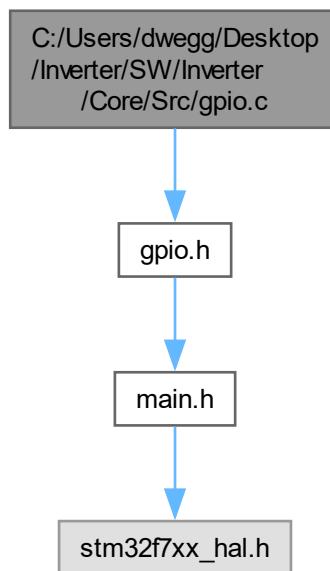
Here is the caller graph for this function:



6.51 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/gpio.c File Reference

This file provides code for the configuration of all used GPIO pins.

```
#include "gpio.h"  
Include dependency graph for gpio.c:
```



Functions

- void [MX_GPIO_Init](#) (void)

6.51.1 Detailed Description

This file provides code for the configuration of all used GPIO pins.

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6.51.2 Function Documentation

6.51.2.1 MX_GPIO_Init()

```
void MX_GPIO_Init (
    void )
```

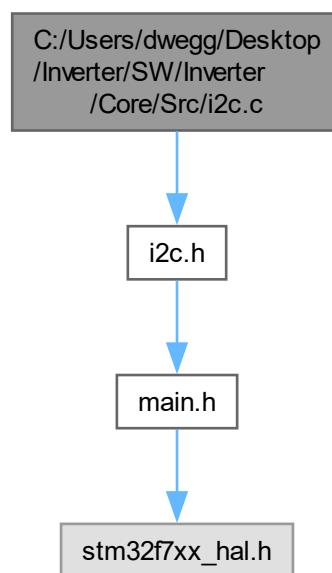
Configure pins as [Analog](#) Input Output EVENT_OUT EXTI PA9 -----> USB_OTG_FS_VBUS PA10 -----> USB_<--_OTG_FS_ID PA11 -----> USB_OTG_FS_DM PA12 -----> USB_OTG_FS_DP Here is the caller graph for this function:



6.52 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/i2c.c File Reference

This file provides code for the configuration of the I2C instances.

```
#include "i2c.h"
Include dependency graph for i2c.c:
```



Functions

- void `MX_I2C1_Init` (void)
- void `HAL_I2C_MspInit` (I2C_HandleTypeDef *i2cHandle)
- void `HAL_I2C_MspDeInit` (I2C_HandleTypeDef *i2cHandle)

Variables

- I2C_HandleTypeDef `hi2c1`

6.52.1 Detailed Description

This file provides code for the configuration of the I2C instances.

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6.52.2 Function Documentation

6.52.2.1 HAL_I2C_MspDeInit()

```
void HAL_I2C_MspDeInit (
    I2C_HandleTypeDef * i2cHandle )
```

I2C1 GPIO Configuration PB6 -----> I2C1_SCL PB7 -----> I2C1_SDA

6.52.2.2 HAL_I2C_MspInit()

```
void HAL_I2C_MspInit (
    I2C_HandleTypeDef * i2cHandle )
```

Initializes the peripherals clock

I2C1 GPIO Configuration PB6 -----> I2C1_SCL PB7 -----> I2C1_SDA
Here is the call graph for this function:



6.52.2.3 MX_I2C1_Init()

```
void MX_I2C1_Init (
    void )
```

Configure Analogue filter

Configure Digital filterHere is the call graph for this function:



Here is the caller graph for this function:



6.52.3 Variable Documentation

6.52.3.1 hi2c1

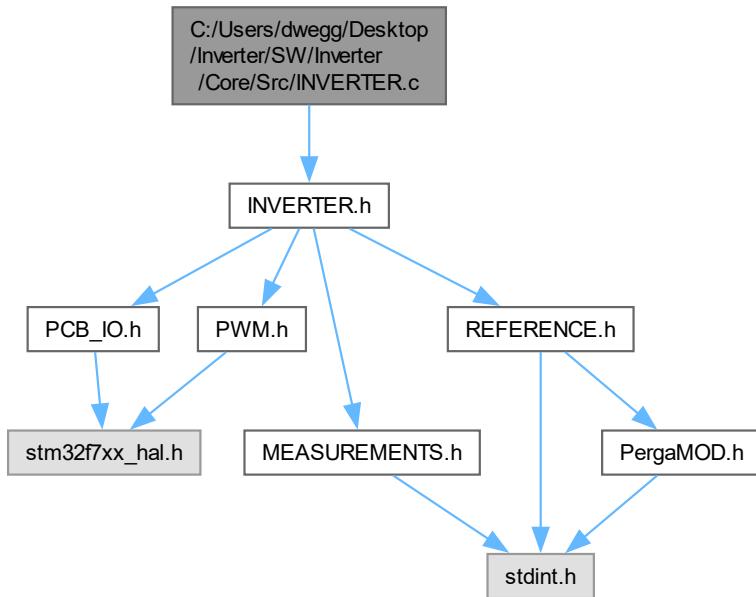
```
I2C_HandleTypeDef hi2c1
```

6.53 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/INVERTER.c File Reference

This file provides code for the inverter struct.

```
#include "INVERTER.h"
```

Include dependency graph for INVERTER.c:



Functions

- void `initialize_inverter` (volatile InverterStruct *inv, LED *led, GPIO_TypeDef *enable_port, uint16_t enable_pin, TIM_HandleTypeDef *htim, ADC_HandleTypeDef *hadc)

Initialize the inverter.

Variables

- volatile InverterStruct `inverter_left` = {0}
Left inverter structure.
- volatile InverterStruct `inverter_right` = {0}
Right inverter structure.

6.53.1 Detailed Description

This file provides code for the inverter struct.

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6.53.2 Function Documentation

6.53.2.1 initialize_inverter()

```
void initialize_inverter (
    volatile InverterStruct * inv,
    LED * led,
    GPIO_TypeDef * enable_port,
    uint16_t enable_pin,
    TIM_HandleTypeDef * htim,
    ADC_HandleTypeDef * hadc )
```

Initialize the inverter.

This function initializes the inverter structure with the specified [LED](#), GPIO port, and pin.

Parameters

out	<i>inv</i>	Pointer to the inverter structure.
in	<i>led</i>	Pointer to the LED structure.
in	<i>enable_port</i>	Pointer to the GPIO port for enabling/disabling the inverter.
in	<i>enable_pin</i>	Pin number for enabling/disabling the inverter.
in	<i>htim</i>	Timer peripheral for the PWM output.
in	<i>hadc</i>	ADC peripheral for the current phase current and DC voltage sensing.

Here is the caller graph for this function:



6.53.3 Variable Documentation

6.53.3.1 inverter_left

```
volatile InverterStruct inverter_left = {0}
```

Left inverter structure.

External declaration of the left inverter structure.

6.53.3.2 inverter_right

```
volatile InverterStruct inverter_right = {0}
```

Right inverter structure.

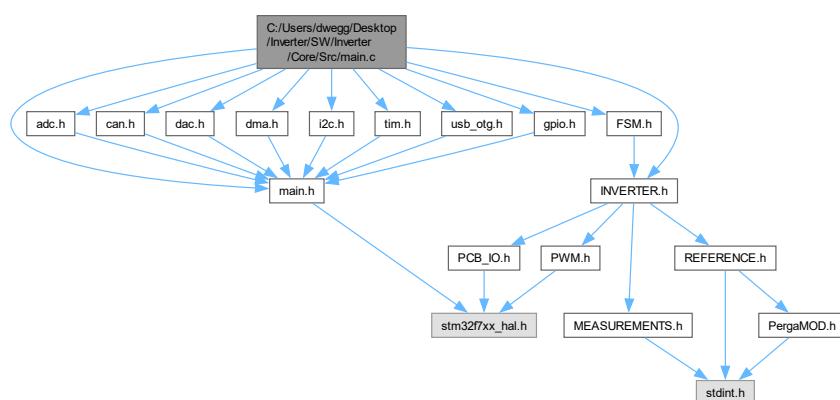
External declaration of the right inverter structure.

6.54 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/main.c File Reference

: Main program body

```
#include "main.h"
#include "adc.h"
#include "can.h"
#include "dac.h"
#include "dma.h"
#include "i2c.h"
#include "tim.h"
#include "usb_otg.h"
#include "gpio.h"
#include "FSM.h"
#include "INVERTER.h"
```

Include dependency graph for main.c:



Functions

- void [SystemClock_Config](#) (void)
System Clock Configuration.
- int [main](#) (void)
The application entry point.
- void [Error_Handler](#) (void)
This function is executed in case of error occurrence.

6.54.1 Detailed Description

: Main program body

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6.54.2 Function Documentation

6.54.2.1 Error_Handler()

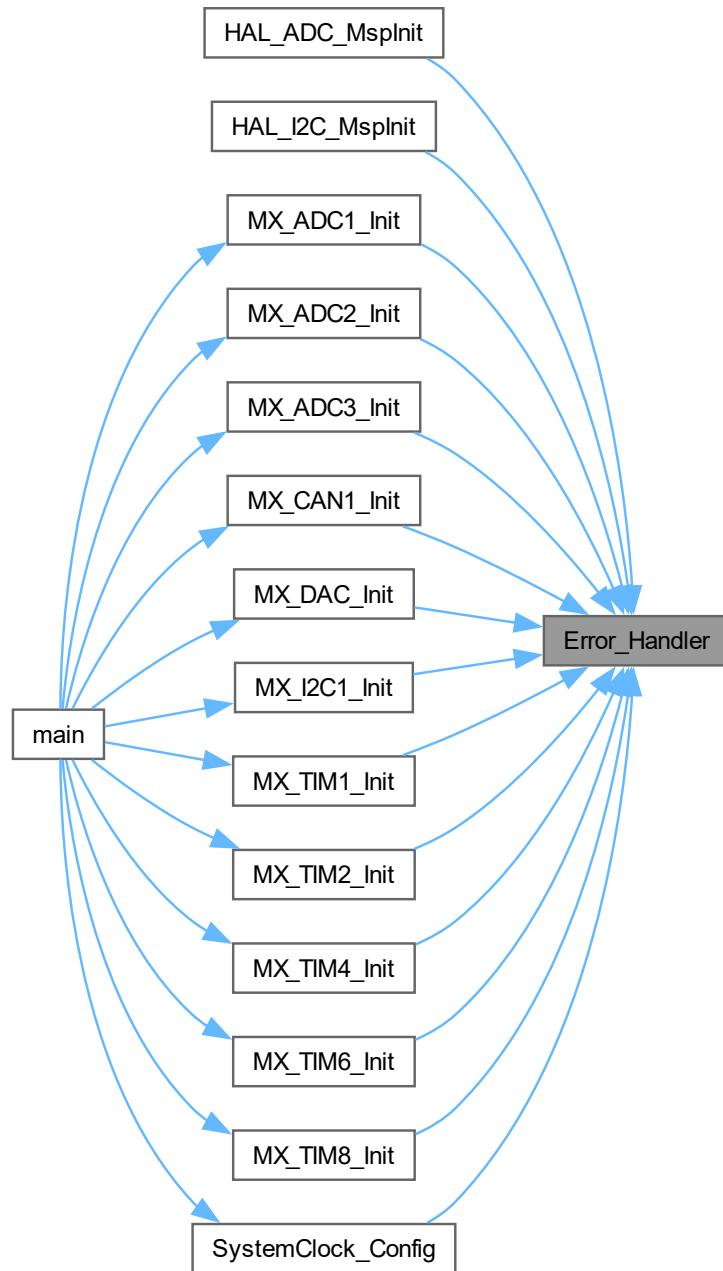
```
void Error_Handler (
    void )
```

This function is executed in case of error occurrence.

Return values

<i>None</i>	
-------------	--

Here is the caller graph for this function:



6.54.2.2 main()

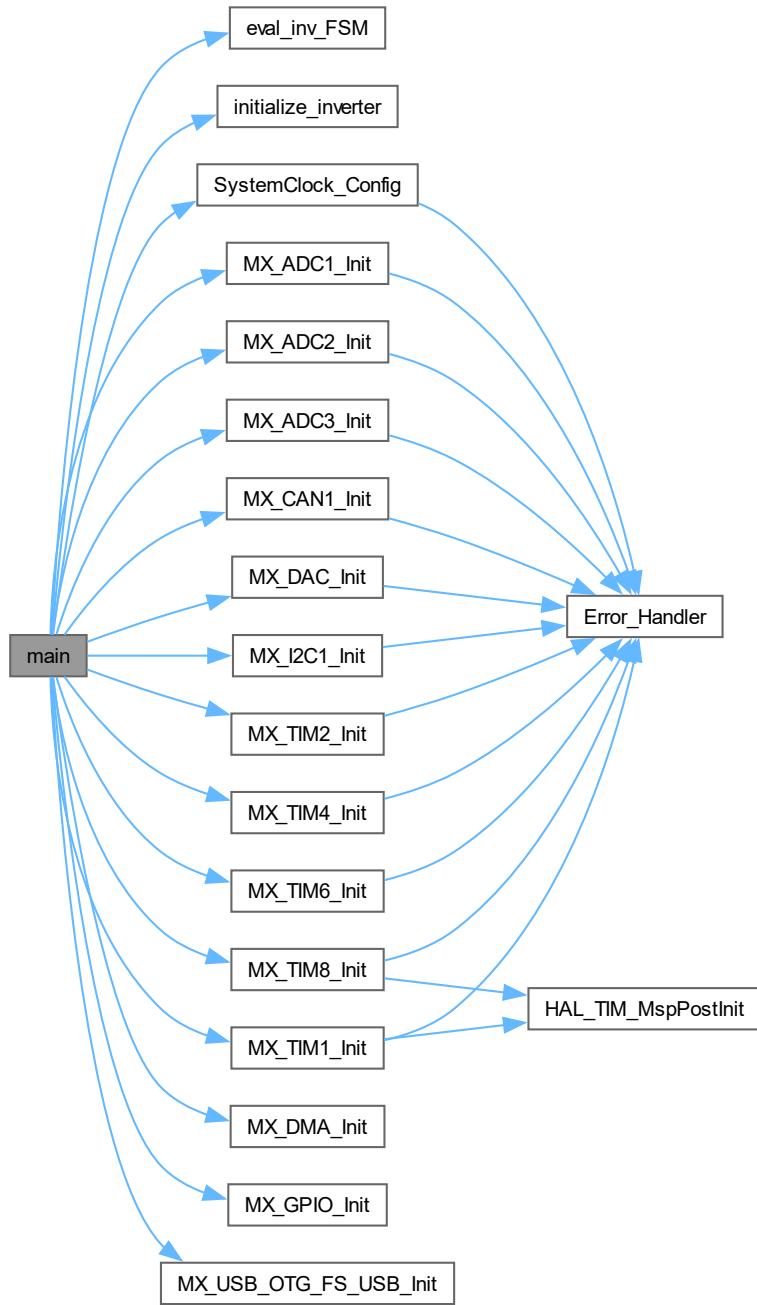
```
int main (
    void )
```

The application entry point.

Return values

int	
-----	--

Here is the call graph for this function:



6.54.2.3 SystemClock_Config()

```
void SystemClock_Config (
```

```
void )
```

System Clock Configuration.

Return values

None	
------	--

Configure the main internal regulator output voltage

Initializes the RCC Oscillators according to the specified parameters in the RCC_OsclInitTypeDef structure.

Activate the Over-Drive mode

Initializes the CPU, AHB and APB buses clocksHere is the call graph for this function:



Here is the caller graph for this function:

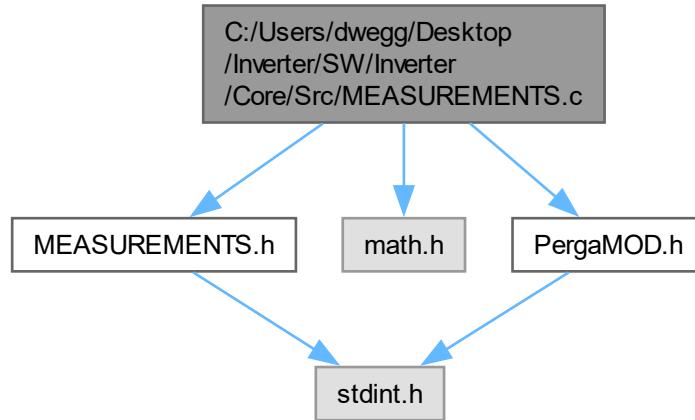


6.55 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/← MEASUREMENTS.c File Reference

This file provides functions for handling measurements.

```
#include "MEASUREMENTS.h"  
#include <math.h>
```

```
#include <PergaMOD.h>
Include dependency graph for MEASUREMENTS.c:
```



Functions

- `uint8_t get_currents_voltage (volatile uint32_t ADC_raw[], volatile Analog *analog)`
Get electrical ADC measurements.
- `float get_linear (uint32_t bits, float slope, float offset)`
Convert ADC reading to physical measurement with linear response.
- `void get_idiq (float ia, float ib, float ic, float theta_e, float *id_meas, float *iq_meas)`
Computes d-q currents from current measurements and electrical angle.
- `float get_temperature (uint32_t bits, const float tempLUT[])`
Retrieves temperature from a lookup table based on ADC bits.

Variables

- `const float tempLUT_inverter [] = {-2.45, -2.44, -2.44, -2.43, -2.42, -2.42, -2.41, -2.41, -2.40, -2.39, -2.39, -2.38, -2.37, -2.37, -2.36, -2.36, -2.35, -2.34, -2.34, -2.33, -2.32, -2.32, -2.31, -2.31, -2.30, -2.29, -2.29, -2.28, -2.27, -2.27, -2.26, -2.26, -2.25, -2.24, -2.24, -2.23, -2.22, -2.22, -2.21, -2.21, -2.20, -2.20, -2.20, -2.19, -2.19, -2.18, -2.17, -2.17, -2.16, -2.15, -2.15, -2.14, -2.14, -2.13, -2.12, -2.12, -2.11, -2.10, -2.10, -2.10, -2.09, -2.08, -2.08, -2.08, -2.07, -2.07, -2.06, -2.05, -2.05, -2.04, -2.03, -2.03, -2.02, -2.01, -2.01, -2.01, -2.00, -2.00, -2.00, -1.99, -1.98, -1.98, -1.98, -1.97, -1.96, -1.96, -1.95, -1.94, -1.94, -1.93, -1.93, -1.92, -1.92, -1.91, -1.91, -1.90, -1.89, -1.89, -1.88, -1.87, -1.87, -1.87, -1.86, -1.86, -1.85, -1.84, -1.84, -1.83, -1.83, -1.82, -1.82, -1.81, -1.80, -1.80, -1.79, -1.78, -1.78, -1.77, -1.77, -1.77, -1.76, -1.75, -1.75, -1.75, -1.74, -1.73, -1.73, -1.72, -1.71, -1.71, -1.70, -1.69, -1.69, -1.68, -1.67, -1.67, -1.66, -1.66, -1.65, -1.64, -1.64, -1.63, -1.62, -1.62, -1.61, -1.60, -1.60, -1.59, -1.58, -1.58, -1.57, -1.57, -1.56, -1.56, -1.55, -1.54, -1.54, -1.53, -1.53, -1.52, -1.51, -1.51, -1.50, -1.49, -1.49, -1.48, -1.48, -1.47, -1.47, -1.46, -1.46, -1.45, -1.45, -1.44, -1.44, -1.43, -1.43, -1.42, -1.41, -1.41, -1.40, -1.39, -1.39, -1.38, -1.37, -1.37, -1.36, -1.36, -1.35, -1.34, -1.34, -1.33, -1.32, -1.32, -1.31, -1.30, -1.30, -1.29, -1.28, -1.28, -1.27, -1.26, -1.26, -1.25, -1.25, -1.24, -1.24, -1.23, -1.22, -1.22, -1.21, -1.21, -1.20, -1.20, -1.19, -1.18, -1.18, -1.17, -1.16, -1.16, -1.15, -1.15, -1.14, -1.14, -1.13, -1.13, -1.12, -1.12, -1.11, -1.11, -1.10, -1.10, -1.10, -1.09, -1.09, -1.08, -1.08, -1.07, -1.06, -1.06, -1.05, -1.04, -1.04, -1.04, -1.03, -1.02, -1.02, -1.01, -1.01, -1.00, -1.00, -0.99, -0.98, -0.98, -0.98, -0.97, -0.96, -0.96, -0.95, -0.94, -0.94, -0.93, -0.93, -0.92, -0.92, -0.91, -0.90, -0.90, -0.89, -0.88, -0.88, -0.87, -0.86, -0.86, -0.85, -0.84, -0.84, -0.83, -0.82, -0.82, -0.81, -0.80, -0.80, -0.79, -0.79, -0.78, -0.78, -0.77, -0.76, -0.76, -0.75, -0.75, -0.74, -0.73, -0.73, -0.72, -0.71, -0.71, -0.70, -0.70, -0.69, -0.69, -0.69, -0.68, -0.68, -0.67, -0.67, -0.66, -0.66, -0.65, -0.65, -0.64, -0.64, -0.63, -0.63, -0.62, -0.61}`

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28.68, 28.71, 28.73, 28.76, 28.78, 28.81, 28.83, 28.86, 28.88, 28.91, 28.93, 28.96, 28.99, 29.01, 29.04, 29.06, 29.09, 29.11, 29.14, 29.17, 29.19, 29.22, 29.24, 29.27, 29.29, 29.32, 29.35, 29.37, 29.40, 29.42, 29.45, 29.48, 29.50, 29.53, 29.55, 29.58, 29.61, 29.63, 29.66, 29.69, 29.71, 29.74, 29.76, 29.79, 29.82, 29.84, 29.87, 29.90, 29.92, 29.95, 29.98, 30.00, 30.03, 30.06, 30.08, 30.11, 30.14, 30.16, 30.19, 30.22, 30.24, 30.27, 30.30, 30.33, 30.35, 30.38, 30.41, 30.43, 30.46, 30.49, 30.52, 30.54, 30.57, 30.60, 30.62, 30.65, 30.68, 30.71, 30.73, 30.76, 30.79, 30.82, 30.84, 30.87, 30.90, 30.93, 30.96, 30.98, 31.01, 31.04, 31.07, 31.09, 31.12, 31.15, 31.18, 31.21, 31.23, 31.26, 31.29, 31.32, 31.35, 31.37, 31.40, 31.43, 31.46, 31.49, 31.52, 31.54, 31.57, 31.60, 31.63, 31.66, 31.69, 31.72, 31.74, 31.77, 31.80, 31.83, 31.86, 31.89, 31.92, 31.95, 31.97, 32.00, 32.03, 32.06, 32.09, 32.12, 32.15, 32.18, 32.21, 32.24, 32.27, 32.29, 32.32, 32.35, 32.38, 32.41, 32.44, 32.47, 32.50, 32.53, 32.56, 32.59, 32.62, 32.65, 32.68, 32.71, 32.74, 32.77, 32.80, 32.83, 32.86, 32.89, 32.92, 32.95, 32.98, 33.01, 33.04, 33.07, 33.10, 33.13, 33.16, 33.19, 33.22, 33.25, 33.28, 33.31, 33.34, 33.37, 33.40, 33.43, 33.46, 33.49, 33.53, 33.56, 33.59, 33.62, 33.65, 33.68, 33.71, 33.74, 33.77, 33.80, 33.84, 33.87

87, 33.90, 33.93, 33.96, 33.99, 34.02, 34.05, 34.09, 34.12, 34.15, 34.18, 34.21, 34.24, 34.28, 34.31, 34.34, 34.37, 34.40, 34.43, 34.47, 34.50, 34.53, 34.56, 34.59, 34.63, 34.66, 34.69, 34.72, 34.76, 34.79, 34.82, 34.85, 34.89, 34.92, 34.95, 34.98, 35.02, 35.05, 35.08, 35.11, 35.15, 35.18, 35.21, 35.25, 35.28, 35.31, 35.35, 35.38, 35.41, 35.44, 35.48, 35.51, 35.54, 35.58, 35.61, 35.65, 35.68, 35.71, 35.75, 35.78, 35.81, 35.85, 35.88, 35.91, 35.95, 35.98, 36.02, 36.05, 36.08, 36.12, 36.15, 36.19, 36.22, 36.26, 36.29, 36.33, 36.36, 36.39, 36.43, 36.46, 36.50, 36.53, 36.57, 36.60, 36.64, 36.67, 36.71, 36.74, 36.78, 36.81, 36.85, 36.88, 36.92, 36.95, 36.99, 37.02, 37.06, 37.09, 37.13, 37.17, 37.20, 37.24, 37.27, 37.31, 37.34, 37.38, 37.42, 37.45, 37.49, 37.52, 37.56, 37.60, 37.63, 37.67, 37.71, 37.74, 37.78, 37.82, 37.85, 37.89, 37.93, 37.96, 38.00, 38.04, 38.07, 38.11, 38.15, 38.18, 38.22, 38.26, 38.30, 38.33, 38.37, 38.41, 38.44, 38.48, 38.52, 38.56, 38.60, 38.63, 38.67, 38.71, 38.75, 38.78, 38.82, 38.86, 38.90, 38.94, 38.97, 39.01, 39.05, 39.09, 39.13, 39.17, 39.21, 39.24, 39.28, 39.32, 39.36, 39.40, 39.44, 39.48, 39.52, 39.56, 39.59, 39.63, 39.67, 39.71, 39.75, 39.79, 39.83, 39.87, 39.91, 39.95, 39.99, 40.03, 40.07, 40.11, 40.15, 40.19, 40.23, 40.27, 40.31, 40.35, 40.39, 40.43, 40.47, 40.51, 40.55, 40.59, 40.64, 40.68, 40.72, 40.76, 40.80, 40.84, 40.88, 40.92, 40.96, 41.01, 41.05, 41.09, 41.13, 41.17, 41.21, 41.26, 41.30, 41.34, 41.38, 41.42, 41.47, 41.51, 41.55, 41.59, 41.64, 41.68, 41.72, 41.76, 41.81, 41.85, 41.89, 41.93, 41.98, 42.02, 42.06, 42.11, 42.15, 42.19, 42.24, 42.28, 42.32, 42.37, 42.41, 42.46, 42.50, 42.54, 42.59, 42.63, 42.68, 42.72, 42.76, 42.81, 42.85, 42.90, 42.94, 42.99, 43.03, 43.08, 43.12, 43.17, 43.21, 43.26, 43.30, 43.35, 43.39, 43.44, 43.48, 43.53, 43.58, 43.62, 43.67, 43.71, 43.76, 43.81, 43.85, 43.90, 43.94, 43.99, 44.04, 44.08, 44.13, 44.18, 44.23, 44.27, 44.32, 44.37, 44.41, 44.46, 44.51, 44.56, 44.60, 44.65, 44.70, 44.75, 44.80, 44.84, 44.89, 44.94, 44.99, 45.04, 45.08, 45.13, 45.18, 45.23, 45.28, 45.33, 45.38, 45.43, 45.48, 45.53, 45.57, 45.62, 45.67, 45.72, 45.77, 45.82, 45.87, 45.92, 45.97, 46.02, 46.07, 46.12, 46.17, 46.23, 46.28, 46.33, 46.38, 46.43, 46.48, 46.53, 46.58, 46.63, 46.69, 46.74, 46.79, 46.84, 46.89, 46.95, 47.00, 47.05, 47.10, 47.15, 47.21, 47.26, 47.31, 47.37, 47.42, 47.47, 47.52, 47.58, 47.63, 47.69, 47.74, 47.79, 47.85, 47.90, 47.95, 48.01, 48.06, 48.12, 48.17, 48.23, 48.28, 48.34, 48.39, 48.45, 48.50, 48.56, 48.61, 48.67, 48.72, 48.78, 48.84, 48.89, 48.95, 49.00, 49.06, 49.12, 49.17, 49.23, 49.29, 49.34, 49.40, 49.46, 49.52, 49.57, 49.63, 49.69, 49.75, 49.80, 49.86, 49.92, 49.98, 50.04, 50.10, 50.16, 50.21, 50.27, 50.33, 50.39, 50.45, 50.51, 50.57, 50.63, 50.69, 50.75, 50.81, 50.87, 50.93, 50.99, 51.05, 51.11, 51.17, 51.24, 51.30, 51.36, 51.42, 51.48, 51.54, 51.61, 51.67, 51.73, 51.79, 51.86, 51.92, 51.98, 52.04, 52.11, 52.17, 52.23, 52.30, 52.36, 52.43, 52.49, 52.55, 52.62, 52.68, 52.75, 52.81, 52.88, 52.94, 53.01, 53.07, 53.14, 53.21, 53.27, 53.34, 53.40, 53.47, 53.54, 53.60, 53.67, 53.74, 53.80, 53.87, 53.94, 54.01, 54.08, 54.14, 54.21, 54.28, 54.35, 54.42, 54.49, 54.56, 54.63, 54.70, 54.76, 54.83, 54.90, 54.98, 55.05, 55.12, 55.19, 55.26, 55.33, 55.40, 55.47, 55.54, 55.62, 55.69, 55.76, 55.83, 55.91, 55.98, 56.05, 56.12, 56.20, 56.27, 56.35, 56.42, 56.49, 56.57, 56.64, 56.72, 56.79, 56.87, 56.94, 57.02, 57.10, 57.17, 57.25, 57.32, 57.40, 57.48, 57.56, 57.63, 57.71, 57.79, 57.87, 57.94, 58.02, 58.10, 58.18, 58.26, 58.34, 58.42, 58.50, 58.58, 58.66, 58.74, 58.82, 58.90, 58.98, 59.06, 59.15, 59.23, 59.31, 59.39, 59.48, 59.56, 59.64, 59.72, 59.81, 59.89, 59.98, 60.06, 60.15, 60.23, 60.32, 60.40, 60.49, 60.57, 60.66, 60.75, 60.83, 60.92, 61.01, 61.10, 61.18, 61.27, 61.36, 61.45, 61.54, 61.63, 61.72, 61.81, 61.90, 61.99, 62.08, 62.17, 62.26, 62.35, 62.44, 62.54, 62.63, 62.72, 62.82, 62.91, 63.00, 63.10, 63.19, 63.29, 63.38, 63.48, 63.57, 63.67, 63.76, 63.86, 63.96, 64.06, 64.15, 64.25, 64.35, 64.45, 64.55, 64.65, 64.75, 64.85, 64.95, 65.05, 65.15, 65.25, 65.35, 65.46, 65.56, 65.66, 65.76, 65.87, 65.97, 66.08, 66.18, 66.29, 66.39, 66.50, 66.61, 66.71, 66.82, 66.93, 67.03, 67.14, 67.25, 67.36, 67.47, 67.58, 67.69, 67.80, 67.91, 68.03, 68.14, 68.25, 68.36, 68.48, 68.59, 68.71, 68.82, 68.94, 69.05, 69.17, 69.29, 69.40, 69.52, 69.64, 69.76, 69.88, 70.00, 70.12, 70.24, 70.36, 70.48, 70.60, 70.73, 70.85, 70.97, 71.10, 71.22, 71.35, 71.47, 71.60, 71.73, 71.86, 71.98, 72.11, 72.24, 72.37, 72.50, 72.63, 72.76, 72.90, 73.03, 73.16, 73.30, 73.43, 73.57, 73.70, 73.84, 73.98, 74.11, 74.25, 74.39, 74.53, 74.67, 74.81, 74.95, 75.10, 75.24, 75.38, 75.53, 75.67, 75.82, 75.97, 76.11, 76.26, 76.41, 76.56, 76.71, 76.86, 77.01, 77.17, 77.32, 77.47, 77.63, 77.78, 77.94, 78.10, 78.26, 78.42, 78.58, 78.74, 78.90, 79.06, 79.23, 79.39, 79.55, 79.72, 79.89, 80.06, 80.23, 80.40, 80.57, 80.74, 80.91, 81.08, 81.26, 81.44, 81.61, 81.79, 81.97, 82.15, 82.33, 82.51, 82.70, 82.88, 83.07, 83.25, 83.44, 83.63, 83.82, 84.01, 84.20, 84.40, 84.59, 84.79, 84.98, 85.18, 85.38, 85.58, 85.79, 85.99, 86.20, 86.40, 86.61, 86.82, 87.03, 87.24, 87.46, 87.67, 87.89, 88.11, 88.33, 88.55, 88.77, 89.00, 89.22, 89.45, 89.68, 89.91, 90.14, 90.38, 90.62, 90.85, 91.09, 91.34, 91.58, 91.82, 92.07, 92.32, 92.57, 92.83, 93.08, 93.34, 93.60, 93.86, 94.13, 94.39, 94.66, 94.93, 95.20, 95.48, 95.76, 96.04, 96.32, 96.61, 96.89, 97.18, 97.48, 97.77, 98.07, 98.37, 98.68, 98.98, 99.29, 99.61, 99.92, 100.24, 100.56, 100.89, 101.22, 101.55, 101.88, 102.22, 102.56, 102.91, 103.26, 103.61, 103.97, 104.33, 104.70, 105.07, 105.44, 105.82, 106.20, 106.58, 106.98, 107.37, 107.77, 108.18, 108.59, 109.00, 109.42, 109.85, 110.28, 110.71, 111.16, 111.60, 112.06, 112.52, 112.99, 113.46, 113.94, 114.43, 114.92, 115.42, 115.93, 116.44, 116.97, 117.50, 118.04, 118.59, 119.14, 119.71, 120.29, 120.87, 121.47, 122.07, 122.69, 123.32, 123.95, 124.61, 125.27, 125.94, 126.63, 127.33, 128.05, 128.78, 129.52, 130.29, 131.06, 131.86, 132.67, 133.50, 134.35, 135.22, 136.12, 137.03, 137.97, 138.93, 139.92, 140.93, 141.97, 143.05, 144.15, 145.29, 146.46, 147.67, 148.92, 150.22, 151.55, 152.94, 154.38, 155.87, 157.42, 159.04, 160.72, 162.48, 164.33, 166.26, 168.29, 170.42, 172.68, 175.07,

- volatile uint32_t rawADC_left [4] = {0}
Raw ADC data for the left inverter.
 - volatile uint32_t rawADC_right [4] = {0}
Raw ADC data for the right inverter.
 - volatile uint32_t rawADC_temp [4] = {0}

6.5.1 Detailed Description

This file provides functions for handling measurements.

Attention

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6.55.2 Function Documentation

6.55.2.1 get_currents_voltage()

```
uint8_t get_currents_voltage (
    volatile uint32_t ADC_raw[ ],
    volatile Analog * analog )
```

Get electrical ADC measurements.

Parameters

in	<i>ADC_raw</i>	Pointer to the raw ADC values array.
out	<i>analog</i>	Pointer to the ADC struct to store the results.

Return values

<i>OK</i>	0 if an error occurred, 1 if successful.
-----------	--

Here is the call graph for this function:



Here is the caller graph for this function:



6.55.2.2 get_idiq()

```
void get_idiq (
    float ia,
    float ib,
    float ic,
    float theta_e,
    float * id_meas,
    float * iq_meas )
```

Computes d-q currents from current measurements and electrical angle.

This function computes the d-q currents from phase currents (ABC), theta_e, and stores the results in the provided pointers.

Parameters

in	<i>ia</i>	Phase A current in A.
in	<i>ib</i>	Phase B current in A.
in	<i>ic</i>	Phase C current in A.
in	<i>theta_e</i>	Electrical rotor position in radians.
out	<i>id_meas</i>	Pointer to store the D-axis current.
out	<i>iq_meas</i>	Pointer to store the Q-axis current.

6.55.2.3 get_linear()

```
float get_linear (
    uint32_t bits,
    float slope,
    float offset )
```

Convert ADC reading to physical measurement with linear response.

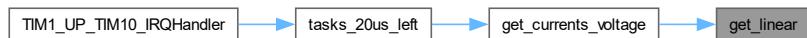
Parameters

in	<i>bits</i>	The ADC reading.
in	<i>slope</i>	The slope (units per volt).
in	<i>offset</i>	The offset (volts at zero).

Return values

<i>measurement</i>	The physical measurement.
--------------------	---------------------------

Here is the caller graph for this function:

**6.55.2.4 get_temperature()**

```
float get_temperature (
    uint32_t bits,
    const float tempLUT[ ] )
```

Retrieves temperature from a lookup table based on ADC bits.

This function retrieves temperature from a lookup table based on the ADC bits. The lookup table (LUT) must have a value for each possible ADC bit combination.

Parameters

in	<i>bits</i>	ADC reading converted to bits.
in	<i>tempLUT</i>	Lookup table containing temperature values.

Returns

Temperature corresponding to the provided ADC bits.

Here is the caller graph for this function:



6.55.3 Variable Documentation

6.55.3.1 rawADC_left

```
volatile uint32_t rawADC_left[4] = {0}
```

Raw ADC data for the left inverter.

External declaration of raw ADC data for the left inverter.

6.55.3.2 rawADC_right

```
volatile uint32_t rawADC_right[4] = {0}
```

Raw ADC data for the right inverter.

External declaration of raw ADC data for the right inverter.

6.55.3.3 rawADC_temp

```
volatile uint32_t rawADC_temp[4] = {0}
```

Raw ADC data for the temperatures.

External declaration of raw ADC data for the temperature readings.

6.55.3.4 tempLUT_inverter

3.18, 3.19, 3.20, 3.21, 3.22, 3.23, 3.24, 3.24, 3.25, 3.26, 3.27, 3.28, 3.29, 3.29, 3.29,
30, 3.31, 3.32, 3.33, 3.34, 3.34, 3.35, 3.36, 3.37, 3.38, 3.38, 3.39, 3.40, 3.41, 3.42, 3.43,
3.43, 3.44, 3.45, 3.46, 3.47, 3.48, 3.48, 3.49, 3.50, 3.51, 3.52, 3.53, 3.53, 3.54, 3.55, 3.55,
3.56, 3.57, 3.58, 3.58, 3.59, 3.60, 3.61, 3.62, 3.63, 3.63, 3.64, 3.65, 3.66, 3.67, 3.68, 3.68,
3.69, 3.70, 3.71, 3.72, 3.73, 3.73, 3.74, 3.75, 3.76, 3.77, 3.78, 3.78, 3.79, 3.80, 3.81, 3.81,
82, 3.83, 3.83, 3.84, 3.85, 3.86, 3.87, 3.88, 3.89, 3.89, 3.90, 3.91, 3.92, 3.93, 3.94, 3.94,
3.95, 3.96, 3.97, 3.98, 3.99, 4.00, 4.00, 4.01, 4.02, 4.03, 4.04, 4.05, 4.05, 4.06, 4.07, 4.07,
4.08, 4.09, 4.10, 4.11, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17, 4.17, 4.18, 4.19, 4.20, 4.21,
4.22, 4.23, 4.23, 4.24, 4.25, 4.26, 4.27, 4.28, 4.29, 4.29, 4.30, 4.31, 4.32, 4.33, 4.34, 4.34,
35, 4.35, 4.36, 4.37, 4.38, 4.39, 4.40, 4.41, 4.42, 4.42, 4.43, 4.44, 4.45, 4.45, 4.46, 4.47, 4.48,
4.48, 4.49, 4.50, 4.51, 4.52, 4.53, 4.54, 4.55, 4.55, 4.56, 4.57, 4.58, 4.59, 4.60, 4.61, 4.61,
62, 4.62, 4.63, 4.64, 4.65, 4.66, 4.67, 4.68, 4.69, 4.69, 4.70, 4.71, 4.72, 4.73, 4.74, 4.75,
4.76, 4.76, 4.77, 4.78, 4.79, 4.80, 4.81, 4.82, 4.83, 4.83, 4.84, 4.85, 4.86, 4.87, 4.88, 4.88,
89, 4.90, 4.91, 4.91, 4.92, 4.93, 4.94, 4.95, 4.96, 4.97, 4.98, 4.99, 4.99, 5.00, 5.01, 5.02,
5.03, 5.04, 5.05, 5.06, 5.07, 5.07, 5.08, 5.09, 5.10, 5.11, 5.12, 5.13, 5.14, 5.15, 5.16, 5.16,
16, 5.17, 5.18, 5.19, 5.20, 5.21, 5.22, 5.23, 5.24, 5.24, 5.25, 5.26, 5.27, 5.28, 5.29, 5.30,
5.31, 5.32, 5.33, 5.34, 5.34, 5.35, 5.36, 5.37, 5.38, 5.39, 5.40, 5.41, 5.42, 5.43, 5.43, 5.43,
44, 5.45, 5.46, 5.47, 5.48, 5.49, 5.50, 5.51, 5.52, 5.53, 5.53, 5.54, 5.55, 5.56, 5.57, 5.58,
5.59, 5.60, 5.61, 5.62, 5.63, 5.64, 5.64, 5.65, 5.66, 5.67, 5.68, 5.69, 5.70, 5.71, 5.72, 5.72,
73, 5.74, 5.75, 5.75, 5.76, 5.77, 5.78, 5.79, 5.80, 5.81, 5.82, 5.83, 5.84, 5.85, 5.86, 5.87,
5.88, 5.88, 5.89, 5.89, 5.90, 5.91, 5.92, 5.93, 5.94, 5.95, 5.96, 5.97, 5.98, 5.99, 6.00, 6.01,
6.01, 6.02, 6.03, 6.04, 6.05, 6.06, 6.07, 6.08, 6.09, 6.10, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16,
6.16, 6.17, 6.18, 6.19, 6.20, 6.21, 6.22, 6.23, 6.24, 6.25, 6.26, 6.27, 6.28, 6.29, 6.30, 6.30,
31, 6.32, 6.32, 6.33, 6.34, 6.35, 6.36, 6.37, 6.38, 6.39, 6.40, 6.41, 6.42, 6.43, 6.44, 6.45,
6.46, 6.47, 6.48, 6.49, 6.50, 6.51, 6.51, 6.52, 6.53, 6.54, 6.55, 6.56, 6.57, 6.58, 6.59, 6.59,
60, 6.61, 6.62, 6.63, 6.64, 6.65, 6.66, 6.67, 6.68, 6.69, 6.70, 6.71, 6.72, 6.73, 6.74, 6.75,
6.75, 6.76, 6.77, 6.78, 6.79, 6.80, 6.81, 6.82, 6.83, 6.84, 6.85, 6.86, 6.87, 6.88, 6.89, 6.89,
90, 6.91, 6.92, 6.93, 6.94, 6.95, 6.96, 6.97, 6.98, 6.99, 7.00, 7.01, 7.02, 7.03, 7.04, 7.05,
7.06, 7.07, 7.08, 7.09, 7.10, 7.11, 7.12, 7.12, 7.13, 7.14, 7.15, 7.16, 7.17, 7.18, 7.19, 7.19,
20, 7.21, 7.22, 7.23, 7.24, 7.25, 7.26, 7.27, 7.28, 7.29, 7.30, 7.31, 7.32, 7.33, 7.34, 7.35,
7.36, 7.37, 7.38, 7.39, 7.40, 7.41, 7.42, 7.43, 7.44, 7.45, 7.46, 7.47, 7.48, 7.49, 7.50, 7.49,
51, 7.52, 7.53, 7.54, 7.55, 7.56, 7.57, 7.58, 7.59, 7.60, 7.61, 7.62, 7.63, 7.64, 7.65, 7.66,
7.67, 7.68, 7.69, 7.70, 7.71, 7.72, 7.73, 7.74, 7.75, 7.76, 7.77, 7.78, 7.79, 7.80, 7.81, 7.81,
82, 7.83, 7.84, 7.85, 7.86, 7.87, 7.88, 7.89, 7.91, 7.92, 7.93, 7.94, 7.95, 7.96, 7.97, 7.98,
7.99, 8.00, 8.01, 8.02, 8.03, 8.04, 8.05, 8.06, 8.07, 8.08, 8.09, 8.10, 8.11, 8.12, 8.13, 8.13,
14, 8.15, 8.16, 8.17, 8.18, 8.19, 8.20, 8.21, 8.22, 8.23, 8.24, 8.25, 8.26, 8.27, 8.29, 8.30,
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46, 8.47, 8.48, 8.49, 8.50, 8.51, 8.52, 8.54, 8.55, 8.56, 8.57, 8.58, 8.59, 8.60, 8.61, 8.62,
8.63, 8.64, 8.65, 8.66, 8.67, 8.68, 8.69, 8.70, 8.71, 8.72, 8.74, 8.75, 8.76, 8.77, 8.78, 8.78,
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11, 12.13, 12.14, 12.15, 12.16, 12.18, 12.19, 12.20, 12.21, 12.23, 12.24, 12.25, 12.26, 12.←
28, 12.29, 12.30, 12.31, 12.33, 12.34, 12.35, 12.36, 12.38, 12.39, 12.40, 12.41, 12.43, 12.←
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10, 13.11, 13.12, 13.14, 13.15, 13.16, 13.18, 13.19, 13.20, 13.22, 13.23, 13.24, 13.25, 13.←
27, 13.28, 13.29, 13.31, 13.32, 13.33, 13.35, 13.36, 13.37, 13.38, 13.40, 13.41, 13.42, 13.←
44, 13.45, 13.46, 13.48, 13.49, 13.50, 13.52, 13.53, 13.54, 13.55, 13.57, 13.58, 13.59, 13.←
61, 13.62, 13.63, 13.65, 13.66, 13.67, 13.69, 13.70, 13.71, 13.73, 13.74, 13.75, 13.77, 13.←
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79, 18.81, 18.82, 18.84, 18.86, 18.87, 18.89, 18.91, 18.92, 18.94, 18.96, 18.97, 18.99, 19.←
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03, 22.05, 22.06, 22.08, 22.10, 22.12, 22.14, 22.16, 22.18, 22.20, 22.22, 22.24, 22.26, 22.←
28, 22.30, 22.31, 22.33, 22.35, 22.37, 22.39, 22.41, 22.43, 22.45, 22.47, 22.49, 22.51, 22.←
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13, 45.18, 45.23, 45.28, 45.33, 45.38, 45.43, 45.48, 45.53, 45.57, 45.62, 45.67, 45.72, 45.←
77, 45.82, 45.87, 45.92, 45.97, 46.02, 46.07, 46.12, 46.17, 46.23, 46.28, 46.33, 46.38, 46.←
43, 46.48, 46.53, 46.58, 46.63, 46.69, 46.74, 46.79, 46.84, 46.89, 46.95, 47.00, 47.05, 47.←
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6.55.3.5 tempLUT_motor

```

const float tempLUT_motor[] = {-2.45, -2.44, -2.44, -2.43, -2.42, -2.42, -2.41, -2.41, -2.41,
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32, -2.31, -2.31, -2.30, -2.29, -2.29, -2.28, -2.27, -2.27, -2.26, -2.26, -2.25, -2.24, -2.24,
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15, -2.15, -2.14, -2.14, -2.13, -2.12, -2.12, -2.11, -2.10, -2.10, -2.09, -2.08, -2.08, -2.08,
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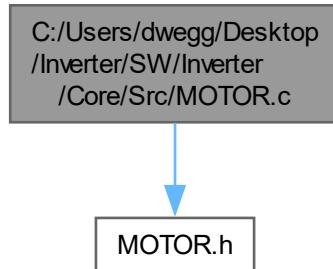
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18, 66.29, 66.39, 66.50, 66.61, 66.71, 66.82, 66.93, 67.03, 67.14, 67.25, 67.36, 67.47, 67.←
58, 67.69, 67.80, 67.91, 68.03, 68.14, 68.25, 68.36, 68.48, 68.59, 68.71, 68.82, 68.94, 69.←
05, 69.17, 69.29, 69.40, 69.52, 69.64, 69.76, 69.88, 70.00, 70.12, 70.24, 70.36, 70.48, 70.←
60, 70.73, 70.85, 70.97, 71.10, 71.22, 71.35, 71.47, 71.60, 71.73, 71.86, 71.98, 72.11, 72.←
24, 72.37, 72.50, 72.63, 72.76, 72.90, 73.03, 73.16, 73.30, 73.43, 73.57, 73.70, 73.84, 73.←
98, 74.11, 74.25, 74.39, 74.53, 74.67, 74.81, 74.95, 75.10, 75.24, 75.38, 75.53, 75.67, 75.←
82, 75.97, 76.11, 76.26, 76.41, 76.56, 76.71, 76.86, 77.01, 77.17, 77.32, 77.47, 77.63, 77.←
78, 77.94, 78.10, 78.26, 78.42, 78.58, 78.74, 78.90, 79.06, 79.23, 79.39, 79.55, 79.72, 79.←
89, 80.06, 80.23, 80.40, 80.57, 80.74, 80.91, 81.08, 81.26, 81.44, 81.61, 81.79, 81.97, 82.←
15, 82.33, 82.51, 82.70, 82.88, 83.07, 83.25, 83.44, 83.63, 83.82, 84.01, 84.20, 84.40, 84.←
59, 84.79, 84.98, 85.18, 85.38, 85.58, 85.79, 85.99, 86.20, 86.40, 86.61, 86.82, 87.03, 87.←
24, 87.46, 87.67, 87.89, 88.11, 88.33, 88.55, 88.77, 89.00, 89.22, 89.45, 89.68, 89.91, 90.←
14, 90.38, 90.62, 90.85, 91.09, 91.34, 91.58, 91.82, 92.07, 92.32, 92.57, 92.83, 93.08, 93.←
34, 93.60, 93.86, 94.13, 94.39, 94.66, 94.93, 95.20, 95.48, 95.76, 96.04, 96.32, 96.61, 96.89,
97.18, 97.48, 97.77, 98.07, 98.37, 98.68, 98.98, 99.29, 99.61, 99.92, 100.24, 100.56, 100.89,
101.22, 101.55, 101.88, 102.22, 102.56, 102.91, 103.26, 103.61, 103.97, 104.33, 104.70, 105.←
07, 105.44, 105.82, 106.20, 106.58, 106.98, 107.37, 107.77, 108.18, 108.59, 109.00, 109.42,
109.85, 110.28, 110.71, 111.16, 111.60, 112.06, 112.52, 112.99, 113.46, 113.94, 114.43, 114.←

6.56 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/MOTOR.c File Reference

Source file for motor parameters.

```
#include "MOTOR.h"
Include dependency graph for MOTOR.c:
```



Variables

- `motorParameters motorLeft`
Left motor parameters.
- `motorParameters motorRight`
Right motor parameters.

6.56.1 Detailed Description

Source file for motor parameters.

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6.56.2 Variable Documentation

6.56.2.1 `motorLeft`

`motorParameters motorLeft`

Initial value:

```
= {
    .Ld = 0.00291,
    .Lq = 0.00295,
    .Rs = 1.95,
    .lambda = 0.13391,
    .pp = 4,
    .J = 0.01,
    .b = 0.001,
    .torque_max = 10.0,
    .speed_max_RPM = 8500.0,
    .iPhase_pk_max = 60.0,
    .vDC_max = 450.0
}
```

Left motor parameters.

6.56.2.2 motorRight

```
motorParameters motorRight
```

Initial value:

```
= {
    .Ld = 0.00291,
    .Lq = 0.00295,
    .Rs = 1.95,
    .lambda = 0.13391,
    .pp = 4,
    .J = 0.01,
    .b = 0.001,
    .torque_max = 10.0,
    .speed_max_RPM = 8500.0,
    .iPhase_pk_max = 60.0,
    .vDC_max = 450.0
}
```

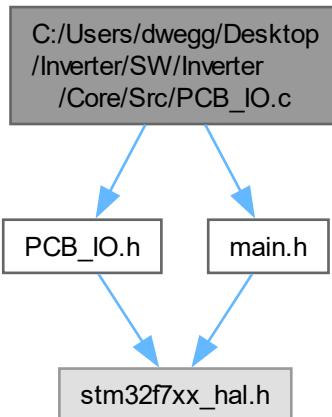
Right motor parameters.

6.57 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/PCB_IO.c File Reference

This file provides functions for handling GPIOs.

```
#include "PCB_IO.h"
#include "main.h"
```

Include dependency graph for PCB_IO.c:



Functions

- void `handle_LED` (`LED *led, uint32_t ms_counter)`
LED handler function.
- void `handle_direction` (`volatile int8_t *dir_left, volatile int8_t *dir_right)`
Handles the direction of the motors.

Variables

- `LED led_left = { .port = LED_LEFT_GPIO_Port, .pin = LED_LEFT_Pin, .mode = LED_MODE_OFF }`
- `LED led_right = { .port = LED_RIGHT_GPIO_Port, .pin = LED_RIGHT_Pin, .mode = LED_MODE_OFF }`
- `LED ledError = { .port = LED_ERR_GPIO_Port, .pin = LED_ERR_Pin, .mode = LED_MODE_OFF }`

6.57.1 Detailed Description

This file provides functions for handling GPIOs.

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6.57.2 Function Documentation

6.57.2.1 handle_direction()

```
void handle_direction (
    volatile int8_t * dir_left,
    volatile int8_t * dir_right )
```

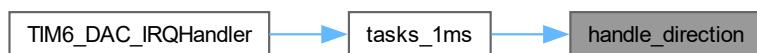
Handles the direction of the motors.

This function reads the state of the DIR switch and updates the directions of both the left and right motors. If one motor is set to rotate clockwise (CW), the other one is set to rotate counterclockwise (CCW), and vice versa.

Parameters

<code>dir_left</code>	Pointer to the direction parameter in the left inverter structure.
<code>dir_right</code>	Pointer to the direction parameter in the right inverter structure.

Here is the caller graph for this function:



6.57.2.2 handle_LED()

```
void handle_LED (
    LED * led,
    uint32_t ms_counter )
```

LED handler function.

This function handles the LED blinking modes based on the LED mode and current millisecond counter.

Parameters

<i>led</i>	Pointer to the LED structure.
<i>ms_counter</i>	Current millisecond counter.

Here is the caller graph for this function:



6.57.3 Variable Documentation

6.57.3.1 led_left

```
LED led_left = { .port = LED_LEFT_GPIO_Port, .pin = LED_LEFT_Pin, .mode = LED_MODE_OFF }
```

6.57.3.2 led_right

```
LED led_right = { .port = LED_RIGHT_GPIO_Port, .pin = LED_RIGHT_Pin, .mode = LED_MODE_OFF }
```

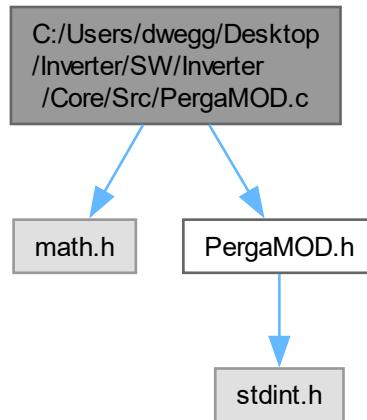
6.57.3.3 ledError

```
LED ledError = { .port = LED_ERR_GPIO_Port, .pin = LED_ERR_Pin, .mode = LED_MODE_OFF }
```

6.58 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/PergaMOD.c File Reference

```
#include <math.h>
#include <PergaMOD.h>
```

Include dependency graph for PergaMOD.c:



Functions

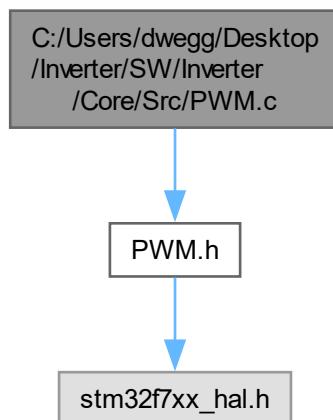
- void `pi_aw_calc` (volatile `pi_aw_struct` *v)
Calculates the Proportional-Integral (PI) control with anti-windup.
- void `pi_init` (volatile `pi_struct` *v)
Initializes the constants of the Proportional-Integral (PI) controller.
- void `pi_calc` (volatile `pi_struct` *v)
Calculates the Proportional-Integral (PI) control action with feedforward and saturation.
- void `pi_extsat_calc` (volatile `pi_struct` *v)
Calculates the Proportional-Integral (PI) control action without saturation for external saturation.
- void `clarke3F_calc` (volatile `clarke3F_struct` *v)
Calculates the Clarke transformation for three-phase signals.
- void `iclarke3F_calc` (volatile `iclarke3F_struct` *v)
Calculates the inverse Clarke transformation for three-phase signals.
- void `rot_calc` (volatile `rot_struct` *v)
Calculates the rotation transformation (clockwise).
- void `irot_calc` (volatile `irot_struct` *v)
Calculates the inverse rotation transformation (counterclockwise).
- void `angle_calc` (volatile `angle_struct` *v)
Generates the angle.
- void `svpwm_calc` (volatile `svpwm_struct` *v)
Calculates the Space Vector Pulse Width Modulation (SVPWM).
- void `rampa_calc` (volatile `rampa_struct` *v)
Calculates the ramp.

- void `rampa_dual_calc` (volatile `rampa_dual_struct` *v)
Calculates the dual ramp.
- void `datalog_calc` (volatile `datalog_struct` *dl)
Calculates the data log.
- void `filtreLP_init` (volatile `filtreLP_struct` *v)
Initializes the first-order filter.
- void `filtreLP_calc` (volatile `filtreLP_struct` *v)
Calculates the first-order filter.
- void `avg_calc_10_samples` (volatile `avg_struct_10` *v)
Calculates the average of 10 samples.
- void `RMS_calc` (volatile `RMS_struct` *v)
Calculates the Root Mean Square (RMS).
- void `step_calc` (volatile `step_struct` *v)
Calculates the step function.

6.59 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/PWM.c File Reference

This file provides functions for controlling PWM output.

```
#include "PWM.h"
Include dependency graph for PWM.c:
```



Functions

- void `enable_PWM` (TIM_HandleTypeDef *htim)
Enable PWM output.
- void `disable_PWM` (TIM_HandleTypeDef *htim)
Disable PWM output.
- void `update_PWM` (TIM_HandleTypeDef *htim, `Duties` duties)
Set PWM duty cycles.

6.59.1 Detailed Description

This file provides functions for controlling PWM output.

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6.59.2 Function Documentation

6.59.2.1 disable_PWM()

```
void disable_PWM (  
    TIM_HandleTypeDef * htim )
```

Disable PWM output.

This function disables PWM output for the specified timer.

Parameters

<i>htim</i>	Pointer to the TIM_HandleTypeDef structure.
-------------	---

6.59.2.2 enable_PWM()

```
void enable_PWM (  
    TIM_HandleTypeDef * htim )
```

Enable PWM output.

This function enables PWM output for the specified timer.

Parameters

<i>htim</i>	Pointer to the TIM_HandleTypeDef structure.
-------------	---

6.59.2.3 update_PWM()

```
void update_PWM (  
    TIM_HandleTypeDef * htim,  
    Duties duties )
```

Set PWM duty cycles.

This function sets the duty cycles for the PWM channels.

Parameters

<i>htim</i>	Pointer to the TIM_HandleTypeDef structure.
<i>duties</i>	Duties structure containing duty cycle values.

Here is the caller graph for this function:

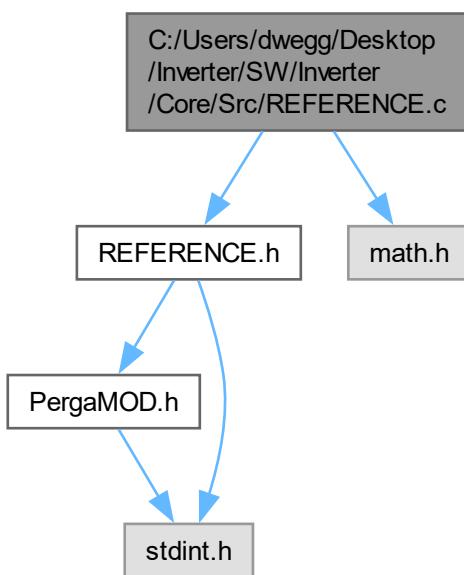


6.60 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/REFERENCE.c File Reference

Source file for torque reference handling.

```
#include "REFERENCE.h"
#include <math.h>
```

Include dependency graph for REFERENCE.c:



Functions

- float `set_torque_direction` (float torque_ref, int8_t direction)

Set torque direction based on inverter direction.
- float `saturate_symmetric` (float ref, float max_value)

Symmetrically saturate a reference value.
- float `limit_torque_to_prevent_overspeed` (float speed_max, float speed_meas, float torque_ref_pre, volatile pi_struct *loop_speed)

Speed loop acts as a torque saturation, reducing torque in order to limit the maximum speed.

6.60.1 Detailed Description

Source file for torque reference handling.

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6.60.2 Function Documentation

6.60.2.1 `limit_torque_to_prevent_overspeed()`

```
float limit_torque_to_prevent_overspeed (
    float speed_max,
    float speed_meas,
    float torque_ref_pre,
    volatile pi_struct * loop_speed )
```

Speed loop acts as a torque saturation, reducing torque in order to limit the maximum speed.

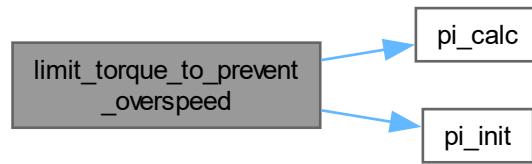
Parameters

in	<code>speed_max</code>	The maximum speed value in RPM.
in	<code>speed_meas</code>	The measured speed value in RPM.
in	<code>torque_ref_pre</code>	The torque reference value before this saturation.
in	<code>loop_speed</code>	Pointer to the speed PI controller structure.

Returns

The limited torque reference value after this saturation.

Here is the call graph for this function:

**6.60.2.2 saturate_symmetric()**

```
float saturate_symmetric (
    float ref,
    float max_value )
```

Symmetrically saturate a reference value.

This function symmetrically saturates a reference value based on the maximum allowed value. If the reference value exceeds the maximum allowed value, it is saturated to the maximum value. If the reference value is less than the negative of the maximum allowed value, it is saturated to the negative of the maximum value.

Parameters

in	<i>ref</i>	The reference value to saturate.
in	<i>max_value</i>	The maximum allowed value for saturation.

Returns

The saturated reference value.

6.60.2.3 set_torque_direction()

```
float set_torque_direction (
    float torque_ref,
    int8_t direction )
```

Set torque direction based on inverter direction.

This function adjusts the torque reference based on the desired direction. If the motor is set to rotate counter-clockwise (CCW), positive torque represents braking. If the motor is set to rotate clockwise (CW), positive torque represents traction.

Parameters

in	<i>torque_ref</i>	The torque reference value to adjust.
in	<i>direction</i>	Pointer to the direction of the inverter (1 for CW, -1 for CCW).

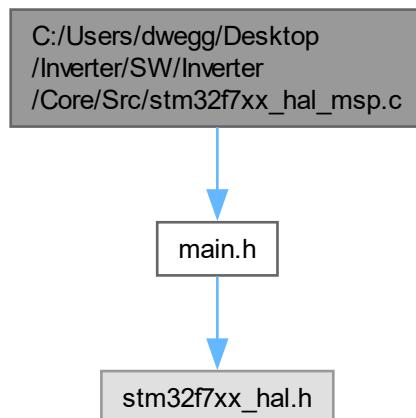
Returns

The adjusted torque reference value.

6.61 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/stm32f7xx_hal_msp.c File Reference

This file provides code for the MSP Initialization and de-Initialization codes.

```
#include "main.h"
Include dependency graph for stm32f7xx_hal_msp.c:
```

**Functions**

- void [HAL_MspInit \(void\)](#)

6.61.1 Detailed Description

This file provides code for the MSP Initialization and de-Initialization codes.

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6.61.2 Function Documentation

6.61.2.1 HAL_MspInit()

```
void HAL_MspInit (
    void )
```

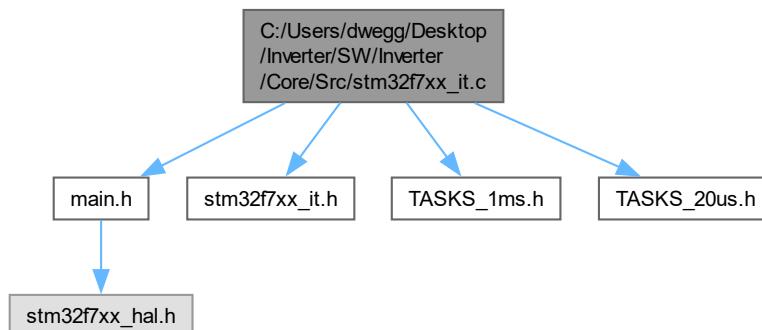
Initializes the Global MSP.

6.62 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/stm32f7xx_it.c File Reference

Interrupt Service Routines.

```
#include "main.h"
#include "stm32f7xx_it.h"
#include "TASKS_1ms.h"
#include "TASKS_20us.h"
```

Include dependency graph for stm32f7xx_it.c:



Functions

- void [NMI_Handler](#) (void)

This function handles Non maskable interrupt.
- void [HardFault_Handler](#) (void)

This function handles Hard fault interrupt.
- void [MemManage_Handler](#) (void)

This function handles Memory management fault.
- void [BusFault_Handler](#) (void)

This function handles Pre-fetch fault, memory access fault.
- void [UsageFault_Handler](#) (void)

This function handles Undefined instruction or illegal state.
- void [SVC_Handler](#) (void)

This function handles System service call via SWI instruction.

- void [DebugMon_Handler](#) (void)
This function handles Debug monitor.
- void [PendSV_Handler](#) (void)
This function handles Pendable request for system service.
- void [SysTick_Handler](#) (void)
This function handles System tick timer.
- void [CAN1_RX0_IRQHandler](#) (void)
This function handles CAN1 RX0 interrupts.
- void [TIM1_UP_TIM10_IRQHandler](#) (void)
This function handles TIM1 update interrupt and TIM10 global interrupt.
- void [TIM6_DAC_IRQHandler](#) (void)
This function handles TIM6 global interrupt, DAC1 and DAC2 underrun error interrupts.
- void [DMA2_Stream0_IRQHandler](#) (void)
This function handles DMA2 stream0 global interrupt.
- void [DMA2_Stream1_IRQHandler](#) (void)
This function handles DMA2 stream1 global interrupt.
- void [DMA2_Stream2_IRQHandler](#) (void)
This function handles DMA2 stream2 global interrupt.

Variables

- DMA_HandleTypeDef [hdma_adc1](#)
- DMA_HandleTypeDef [hdma_adc2](#)
- DMA_HandleTypeDef [hdma_adc3](#)
- CAN_HandleTypeDef [hcan1](#)
- DAC_HandleTypeDef [hdac](#)
- TIM_HandleTypeDef [htim1](#)
- TIM_HandleTypeDef [htim6](#)

6.62.1 Detailed Description

Interrupt Service Routines.

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6.62.2 Function Documentation

6.62.2.1 BusFault_Handler()

```
void BusFault_Handler (
    void )
```

This function handles Pre-fetch fault, memory access fault.

6.62.2.2 CAN1_RX0_IRQHandler()

```
void CAN1_RX0_IRQHandler (
    void )
```

This function handles CAN1 RX0 interrupts.

6.62.2.3 DebugMon_Handler()

```
void DebugMon_Handler (
    void )
```

This function handles Debug monitor.

6.62.2.4 DMA2_Stream0_IRQHandler()

```
void DMA2_Stream0_IRQHandler (
    void )
```

This function handles DMA2 stream0 global interrupt.

6.62.2.5 DMA2_Stream1_IRQHandler()

```
void DMA2_Stream1_IRQHandler (
    void )
```

This function handles DMA2 stream1 global interrupt.

6.62.2.6 DMA2_Stream2_IRQHandler()

```
void DMA2_Stream2_IRQHandler (
    void )
```

This function handles DMA2 stream2 global interrupt.

6.62.2.7 HardFault_Handler()

```
void HardFault_Handler (
    void )
```

This function handles Hard fault interrupt.

6.62.2.8 MemManage_Handler()

```
void MemManage_Handler (
    void )
```

This function handles Memory management fault.

6.62.2.9 NMI_Handler()

```
void NMI_Handler (
    void )
```

This function handles Non maskable interrupt.

6.62.2.10 PendSV_Handler()

```
void PendSV_Handler (
    void )
```

This function handles Pendable request for system service.

6.62.2.11 SVC_Handler()

```
void SVC_Handler (
    void )
```

This function handles System service call via SWI instruction.

6.62.2.12 SysTick_Handler()

```
void SysTick_Handler (
    void )
```

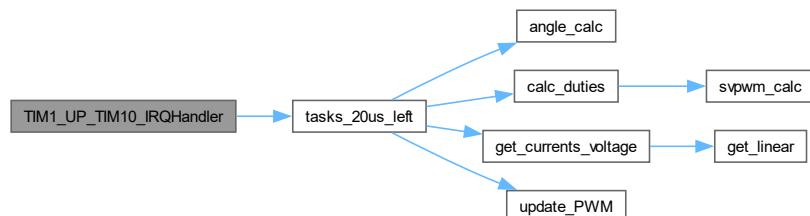
This function handles System tick timer.

6.62.2.13 TIM1_UP_TIM10_IRQHandler()

```
void TIM1_UP_TIM10_IRQHandler (
    void )
```

This function handles TIM1 update interrupt and TIM10 global interrupt.

Here is the call graph for this function:

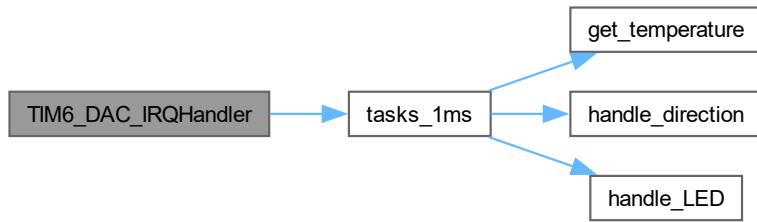


6.62.2.14 TIM6_DAC_IRQHandler()

```
void TIM6_DAC_IRQHandler (
    void )
```

This function handles TIM6 global interrupt, DAC1 and DAC2 underrun error interrupts.

Here is the call graph for this function:



6.62.2.15 UsageFault_Handler()

```
void UsageFault_Handler (
    void )
```

This function handles Undefined instruction or illegal state.

6.62.3 Variable Documentation

6.62.3.1 hcan1

```
CAN_HandleTypeDef hcan1 [extern]
```

6.62.3.2 hdac

```
DAC_HandleTypeDef hdac [extern]
```

6.62.3.3 hdma_adc1

```
DMA_HandleTypeDef hdma_adc1 [extern]
```

6.62.3.4 hdma_adc2

```
DMA_HandleTypeDef hdma_adc2 [extern]
```

6.62.3.5 hdma_adc3

```
DMA_HandleTypeDef hdma_adc3 [extern]
```

6.62.3.6 htim1

```
TIM_HandleTypeDef htim1 [extern]
```

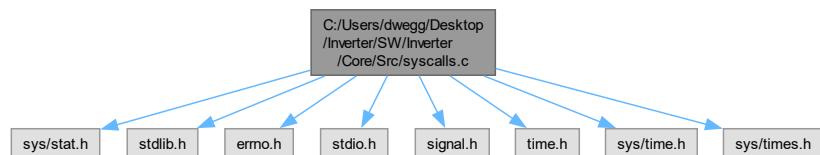
6.62.3.7 htim6

```
TIM_HandleTypeDef htim6 [extern]
```

6.63 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/syscalls.c File Reference

STM32CubeIDE Minimal System calls file.

```
#include <sys/stat.h>
#include <stdlib.h>
#include <errno.h>
#include <stdio.h>
#include <signal.h>
#include <time.h>
#include <sys/time.h>
#include <sys/times.h>
Include dependency graph for syscalls.c:
```



Functions

- int `_io_putchar` (int ch) `__attribute__((weak))`
- int `_io_getchar` (void)
- void `initialise_monitor_handles` ()
- int `_getpid` (void)
- int `_kill` (int pid, int sig)
- void `_exit` (int status)
- `__attribute__((weak))`
- int `_close` (int file)
- int `_fstat` (int file, struct stat *st)
- int `_isatty` (int file)

- int `_lseek` (int file, int ptr, int dir)
- int `_open` (char *path, int flags,...)
- int `_wait` (int *status)
- int `_unlink` (char *name)
- int `_times` (struct tms *buf)
- int `_stat` (char *file, struct stat *st)
- int `_link` (char *old, char *new)
- int `_fork` (void)
- int `_execve` (char *name, char **argv, char **env)

Variables

- char ** `environ` = `__env`

6.63.1 Detailed Description

STM32CubeIDE Minimal System calls file.

Author

Auto-generated by STM32CubeIDE

For more information about which c-functions
need which of these lowlevel functions
please consult the Newlib libc-manual

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6.63.2 Function Documentation

6.63.2.1 `__attribute__()`

```
__attribute__ (
    (weak)  )
```

Here is the call graph for this function:



6.63.2.2 __io_getchar()

```
int __io_getchar (
    void ) [extern]
```

Here is the caller graph for this function:



6.63.2.3 __io_putchar()

```
int __io_putchar (
    int ch ) [extern]
```

6.63.2.4 _close()

```
int _close (
    int file )
```

6.63.2.5 _execve()

```
int _execve (
    char * name,
    char ** argv,
    char ** env )
```

6.63.2.6 _exit()

```
void _exit (
    int status )
```

Here is the call graph for this function:



6.63.2.7 `_fork()`

```
int _fork (
    void )
```

6.63.2.8 `_fstat()`

```
int _fstat (
    int file,
    struct stat * st )
```

6.63.2.9 `_getpid()`

```
int _getpid (
    void )
```

6.63.2.10 `_isatty()`

```
int _isatty (
    int file )
```

6.63.2.11 `_kill()`

```
int _kill (
    int pid,
    int sig )
```

Here is the caller graph for this function:

**6.63.2.12 `_link()`**

```
int _link (
    char * old,
    char * new )
```

6.63.2.13 _lseek()

```
int _lseek (
    int file,
    int ptr,
    int dir )
```

6.63.2.14 _open()

```
int _open (
    char * path,
    int flags,
    ... )
```

6.63.2.15 _stat()

```
int _stat (
    char * file,
    struct stat * st )
```

6.63.2.16 _times()

```
int _times (
    struct tms * buf )
```

6.63.2.17 _unlink()

```
int _unlink (
    char * name )
```

6.63.2.18 _wait()

```
int _wait (
    int * status )
```

6.63.2.19 initialise_monitor_handles()

```
void initialise_monitor_handles ( )
```

6.63.3 Variable Documentation**6.63.3.1 environ**

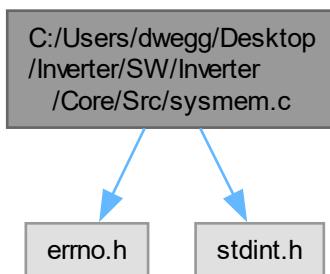
```
char** environ = __env
```

6.64 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/sysmem.c

File Reference

STM32CubeIDE System Memory calls file.

```
#include <errno.h>
#include <stdint.h>
Include dependency graph for sysmem.c:
```



Functions

- void * [_sbrk](#) (ptrdiff_t incr)
_sbrk() allocates memory to the newlib heap and is used by malloc and others from the C library

6.64.1 Detailed Description

STM32CubeIDE System Memory calls file.

Author

Generated by STM32CubeIDE

For more information about which C functions need which of these lowlevel functions please consult the newlib libc manual

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6.64.2 Function Documentation

6.64.2.1 `_sbrk()`

```
void * _sbrk (
    ptrdiff_t incr )
```

`_sbrk()` allocates memory to the newlib heap and is used by malloc and others from the C library

```
* ##### .data # .bss #      newlib heap      # MSP stack #
* #       #      #             # Reserved by _Min_Stack_Size #
* ##### ^-- RAM start      ^-- _end          _estack, RAM end --^
* 
```

This implementation starts allocating at the '`_end`' linker symbol. The '`_Min_Stack_Size`' linker symbol reserves a memory for the MSP stack. The implementation considers '`_estack`' linker symbol to be RAM end. NOTE: If the MSP stack, at any point during execution, grows larger than the reserved size, please increase the '`_Min_Stack_Size`'.

Parameters

<code>incr</code>	Memory size
-------------------	-------------

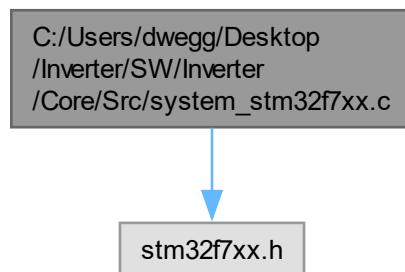
Returns

Pointer to allocated memory

6.65 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/system_stm32f7xx.c File Reference

CMSIS Cortex-M7 Device Peripheral Access Layer System Source File.

```
#include "stm32f7xx.h"
Include dependency graph for system_stm32f7xx.c:
```



Macros

- #define HSE_VALUE ((uint32_t)25000000)
- #define HSI_VALUE ((uint32_t)16000000)

Functions

- void [SystemInit](#) (void)
Setup the microcontroller system Initialize the Embedded Flash Interface, the PLL and update the SystemFrequency variable.
- void [SystemCoreClockUpdate](#) (void)
Update SystemCoreClock variable according to Clock Register Values. The SystemCoreClock variable contains the core clock (HCLK), it can be used by the user application to setup the SysTick timer or configure other parameters.

Variables

- uint32_t [SystemCoreClock](#) = 16000000
- const uint8_t [AHBPrescTable](#) [16] = {0, 0, 0, 0, 0, 0, 0, 0, 1, 2, 3, 4, 6, 7, 8, 9}
- const uint8_t [APBPrescTable](#) [8] = {0, 0, 0, 0, 1, 2, 3, 4}

6.65.1 Detailed Description

CMSIS Cortex-M7 Device Peripheral Access Layer System Source File.

Author

MCD Application Team

This file provides two functions and one global variable to be called from user application:

- [SystemInit\(\)](#): This function is called at startup just after reset and before branch to main program. This call is made inside the "startup_stm32f7xx.s" file.
- SystemCoreClock variable: Contains the core clock (HCLK), it can be used by the user application to setup the SysTick timer or configure other parameters.
- [SystemCoreClockUpdate\(\)](#): Updates the variable SystemCoreClock and must be called whenever the core clock is changed during program execution.

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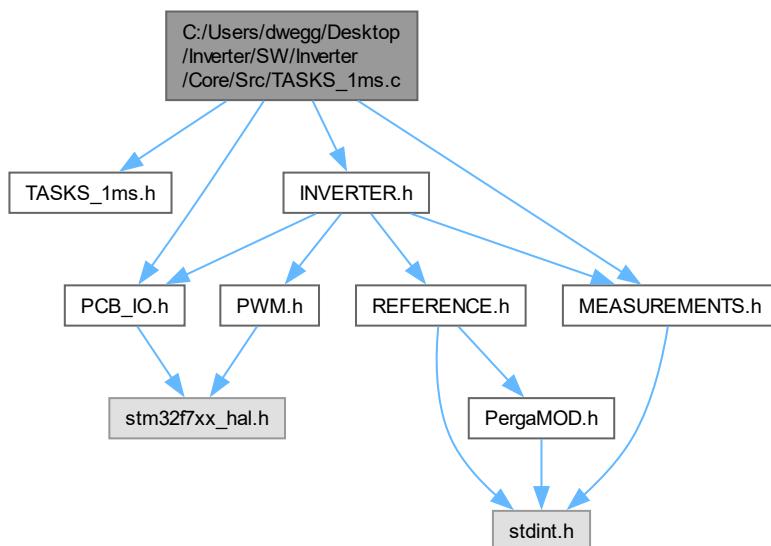
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6.66 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/TASKS_1ms.c File Reference

This file contains functions to execute tasks every 1ms.

```
#include "TASKS_1ms.h"
#include "PCB_IO.h"
#include "INVERTER.h"
#include "MEASUREMENTS.h"

Include dependency graph for TASKS_1ms.c:
```



Functions

- void `tasks_1ms` (void)
Function to be executed every 1ms.

6.66.1 Detailed Description

This file contains functions to execute tasks every 1ms.

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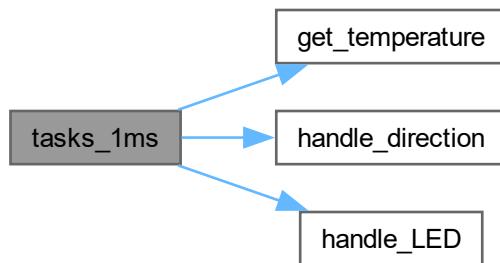
6.66.2 Function Documentation

6.66.2.1 tasks_1ms()

```
void tasks_1ms (
    void )
```

Function to be executed every 1ms.

This function is called by the TIM6 IRQ handler every millisecond. It increments the millisecond counter and executes all the low priority tasks. Here is the call graph for this function:



Here is the caller graph for this function:

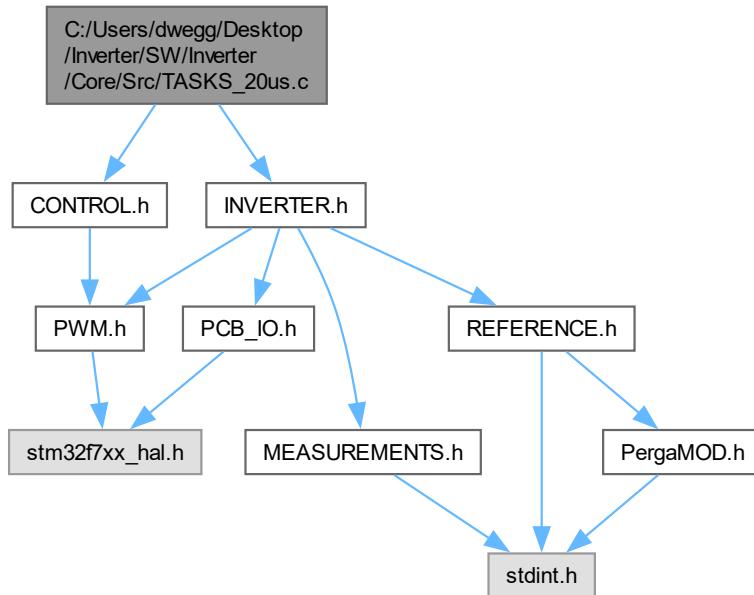


6.67 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/TASKS_20us.c File Reference

This file contains functions executed every 20us in each PWM timer interruption.

```
#include "CONTROL.h"
#include "INVERTER.h"
```

Include dependency graph for TASKS_20us.c:



Functions

- void `tasks_20us_left` (void)
Function to be executed every TS.
- void `tasks_20us_right` (void)
Function to be executed every TS.

Variables

- float `vd_left` = 0.0F
- float `vq_left` = 100.0F
- float `vDC_left` = 300.0F
- float `freq_left` = 50.0F
- `angle_struct angle_left`

6.67.1 Detailed Description

This file contains functions executed every 20us in each PWM timer interruption.

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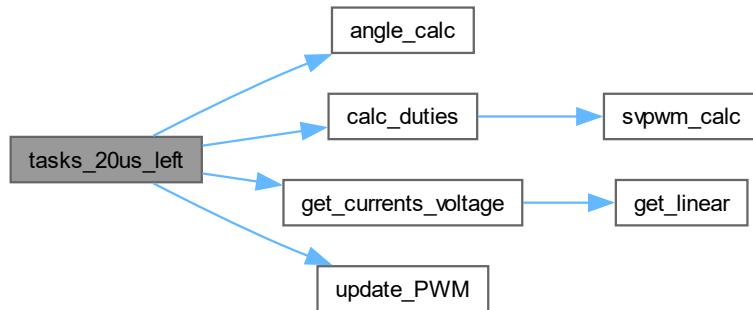
6.67.2 Function Documentation

6.67.2.1 tasks_20us_left()

```
void tasks_20us_left (
    void )
```

Function to be executed every TS.

This function is called by the TIM1 trigger handler every TS. Here is the call graph for this function:



Here is the caller graph for this function:



6.67.2.2 tasks_20us_right()

```
void tasks_20us_right (
    void )
```

Function to be executed every TS.

This function is called by the TIM8 trigger handler every TS.

6.67.3 Variable Documentation

6.67.3.1 angle_left

```
angle_struct angle_left
```

Initial value:

```
= {  
    .freq = 0.2F,  
    .Ts = TS,  
}
```

6.67.3.2 freq_left

```
float freq_left = 50.0F
```

6.67.3.3 vd_left

```
float vd_left = 0.0F
```

6.67.3.4 vDC_left

```
float vDC_left = 300.0F
```

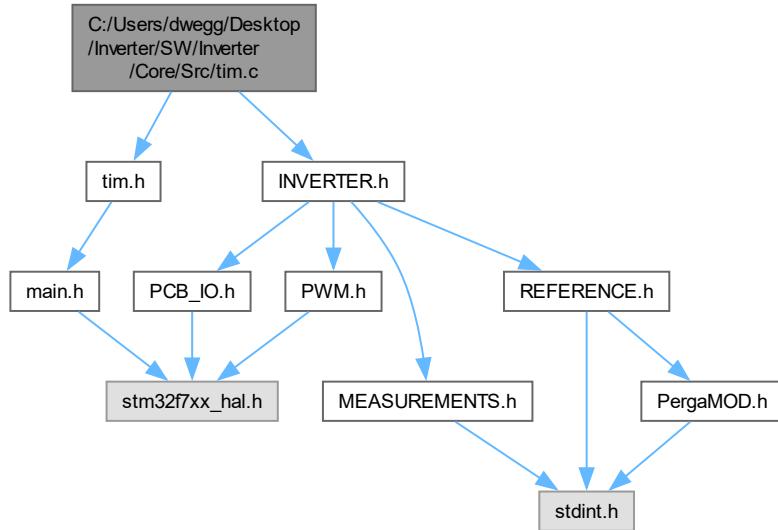
6.67.3.5 vq_left

```
float vq_left = 100.0F
```

6.68 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/tim.c File Reference

This file provides code for the configuration of the TIM instances.

```
#include "tim.h"
#include "INVERTER.h"
Include dependency graph for tim.c:
```



Functions

- void [MX_TIM1_Init](#) (void)
- void [MX_TIM2_Init](#) (void)
- void [MX_TIM4_Init](#) (void)
- void [MX_TIM6_Init](#) (void)
- void [MX_TIM8_Init](#) (void)
- void [HAL_TIM_Base_MspInit](#) (TIM_HandleTypeDef *tim_baseHandle)
- void [HAL_TIM_IC_MspInit](#) (TIM_HandleTypeDef *tim_icHandle)
- void [HAL_TIM_MspPostInit](#) (TIM_HandleTypeDef *timHandle)
- void [HAL_TIM_Base_MspDeInit](#) (TIM_HandleTypeDef *tim_baseHandle)
- void [HAL_TIM_IC_MspDeInit](#) (TIM_HandleTypeDef *tim_icHandle)

Variables

- TIM_HandleTypeDef [htim1](#)
- TIM_HandleTypeDef [htim2](#)
- TIM_HandleTypeDef [htim4](#)
- TIM_HandleTypeDef [htim6](#)
- TIM_HandleTypeDef [htim8](#)

6.68.1 Detailed Description

This file provides code for the configuration of the TIM instances.

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6.68.2 Function Documentation

6.68.2.1 HAL_TIM_Base_MspDeInit()

```
void HAL_TIM_Base_MspDeInit (
    TIM_HandleTypeDef * tim_baseHandle )
```

Uncomment the line below to disable the "TIM6_DAC_IRQHandler" interrupt Be aware, disabling shared interrupt may affect other IPs

6.68.2.2 HAL_TIM_Base_MspInit()

```
void HAL_TIM_Base_MspInit (
    TIM_HandleTypeDef * tim_baseHandle )
```

6.68.2.3 HAL_TIM_IC_MspDeInit()

```
void HAL_TIM_IC_MspDeInit (
    TIM_HandleTypeDef * tim_icHandle )
```

TIM2 GPIO Configuration PB10 -----> TIM2_CH3 PA15 -----> TIM2_CH1

TIM4 GPIO Configuration PD12 -----> TIM4_CH1 PD14 -----> TIM4_CH3

6.68.2.4 HAL_TIM_IC_MspInit()

```
void HAL_TIM_IC_MspInit (
    TIM_HandleTypeDef * tim_icHandle )
```

TIM2 GPIO Configuration PB10 -----> TIM2_CH3 PA15 -----> TIM2_CH1

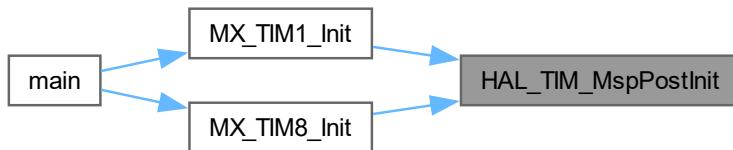
TIM4 GPIO Configuration PD12 -----> TIM4_CH1 PD14 -----> TIM4_CH3

6.68.2.5 HAL_TIM_MspPostInit()

```
void HAL_TIM_MspPostInit (
    TIM_HandleTypeDef * timHandle )
```

TIM1 GPIO Configuration PE8 -----> TIM1_CH1N PE9 -----> TIM1_CH1 PE10 -----> TIM1_CH2N PE11 ----->
TIM1_CH2 PE12 -----> TIM1_CH3N PE13 -----> TIM1_CH3

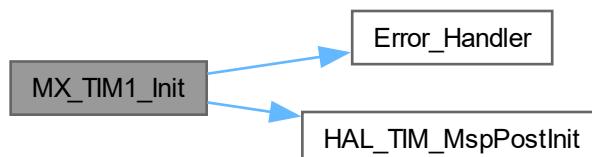
TIM8 GPIO Configuration PA5 -----> TIM8_CH1N PB14 -----> TIM8_CH2N PB15 -----> TIM8_CH3N PC6 ----->
TIM8_CH1 PC7 -----> TIM8_CH2 PC8 -----> TIM8_CH3Here is the caller graph for this function:



6.68.2.6 MX_TIM1_Init()

```
void MX_TIM1_Init (
    void )
```

Here is the call graph for this function:



Here is the caller graph for this function:



6.68.2.7 MX_TIM2_Init()

```
void MX_TIM2_Init (
    void )
```

Here is the call graph for this function:



Here is the caller graph for this function:



6.68.2.8 MX_TIM4_Init()

```
void MX_TIM4_Init (
    void )
```

Here is the call graph for this function:



Here is the caller graph for this function:



6.68.2.9 MX_TIM6_Init()

```
void MX_TIM6_Init (
    void )
```

Here is the call graph for this function:



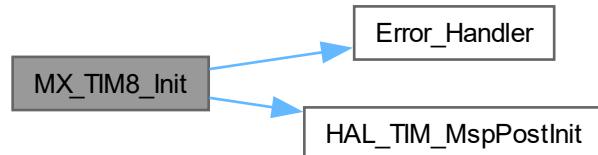
Here is the caller graph for this function:



6.68.2.10 MX_TIM8_Init()

```
void MX_TIM8_Init (
    void )
```

Here is the call graph for this function:



Here is the caller graph for this function:



6.68.3 Variable Documentation

6.68.3.1 htim1

```
TIM_HandleTypeDef htim1
```

6.68.3.2 htim2

```
TIM_HandleTypeDef htim2
```

6.68.3.3 htim4

```
TIM_HandleTypeDef htim4
```

6.68.3.4 htim6

```
TIM_HandleTypeDef htim6
```

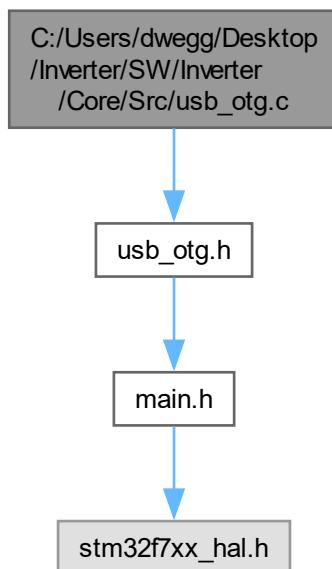
6.68.3.5 htim8

```
TIM_HandleTypeDef htim8
```

6.69 C:/Users/dwegg/Desktop/Inverter/SW/Inverter/Core/Src/usb_otg.c File Reference

This file provides code for the configuration of the USB_OTG instances.

```
#include "usb_otg.h"  
Include dependency graph for usb_otg.c:
```



Functions

- void [MX_USB_OTG_FS_USB_Init](#) (void)

6.69.1 Detailed Description

This file provides code for the configuration of the USB_OTG instances.

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6.69.2 Function Documentation

6.69.2.1 MX_USB_OTG_FS_USB_Init()

```
void MX_USB_OTG_FS_USB_Init (
    void )
```

Here is the caller graph for this function:



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