LINZ CENTER OF MECHATRONICS GMBH

Project Documentation DemoApplication

January 16, 2017

Contents

Part I

X2C Model

1 Version Information

1.1 X2C

- X2Cfull: Version 1072

1.2 Operating System

- OS: Windows 7 6.1

1.3 Scilab

- Scilab: Version 5.5.1.1412169962
- Java: Version 1.6.0_41

2 Model Structure

2.1 Xcos Model

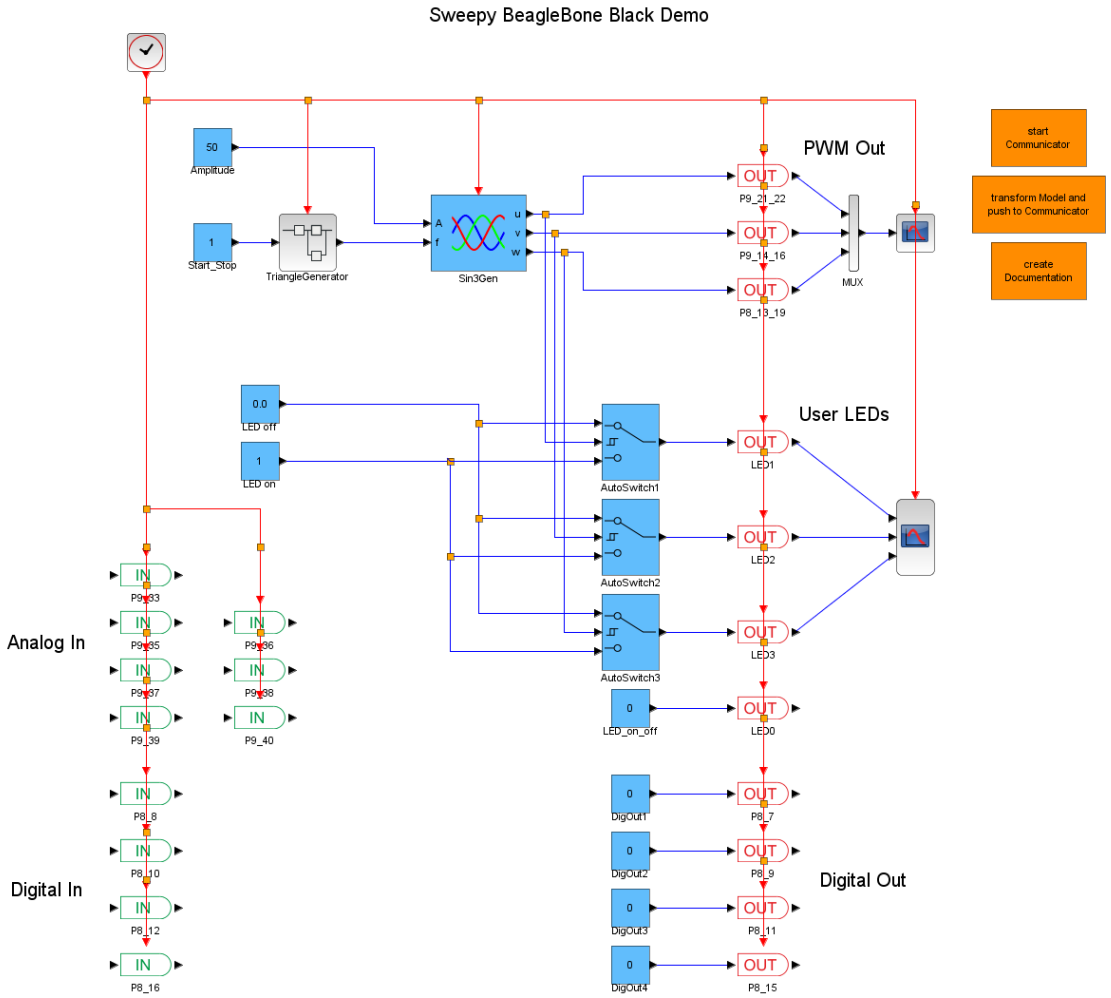

Figure 1: DemoApplication

2.2 Subsystems

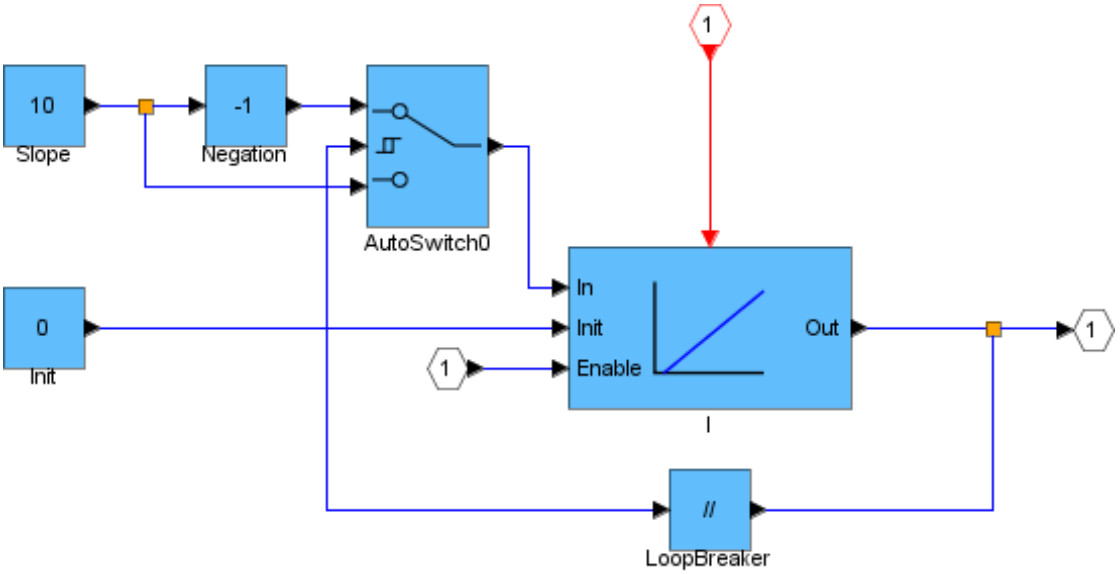

Figure 2: DemoApplication_TriangleGenerator

3 Model Parameter

3.1 Sample Time

Sample Time	
T_S	$100\mu s$

3.2 Scilab Parameter

```
// File with model parameters such as sample time, scaling factors, etc...
//
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// (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS
// SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
//
// $LastChangedRevision: 1069 $
// $LastChangedDate:: 2016-12-23 15:05:57 +0100#$
//
// This file is part of X2C. http://www.mechatronic-simulation.org/

// Sampling time
X2C_sampleTime = 100e-6;    // 10kHz sampling frequency

// Scaling factors

// Controller parameters
```

Listing 1: ModelParameter.sce

4 Mask Parameter

Constant: Amplitude	
Value	50.0
Used Implementation	Float32

AutoSwitch: AutoSwitch1	
Thresh_up	50.0
Thresh_down	50.0
Used Implementation	Float32

AutoSwitch: AutoSwitch2	
Thresh_up	50.0
Thresh_down	50.0
Used Implementation	Float32

AutoSwitch: AutoSwitch3	
Thresh_up	50.0
Thresh_down	50.0
Used Implementation	Float32

Constant: DigOut1	
Value	0.0
Used Implementation	Float32

Constant: DigOut2	
Value	0.0
Used Implementation	Float32

Constant: DigOut3	
Value	0.0
Used Implementation	Float32

Constant: DigOut4	
Value	0.0
Used Implementation	Float32

Constant: LED off	
Value	0.0
Used Implementation	Float32

Constant: LED on	
Value	1.0
Used Implementation	Float32

Constant: LED_on_off	
Value	0.0
Used Implementation	Float32

Sin3Gen: Sin3Gen	
fmax	1000.0
Offset	50.0
ts_fact	1.0
Used Implementation	Float32

Constant: Start_Stop	
Value	1.0
Used Implementation	FiP8

AutoSwitch: TriangleGenerator__AutoSwitch0	
Thresh_up	500.0
Thresh_down	0.0
Used Implementation	Float32

I: TriangleGenerator__I	
Ki	1.0
ts_fact	1.0
Used Implementation	Float32

Constant: TriangleGenerator__Init	
Value	0.0
Used Implementation	Float32

LoopBreaker: TriangleGenerator__LoopBreaker	
Used Implementation	Float32

Negation: TriangleGenerator__Negation	
Used Implementation	Float32

Constant: TriangleGenerator__Slope	
Value	10.0
Used Implementation	Float32

Part II
Frame Program Documentation

5 File Index

5.1 File List

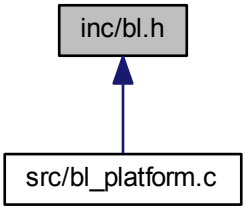
Here is a list of all documented files with brief descriptions:

6 File Documentation

6.1 inc/bl.h File Reference

This file defines boot macros and objects.

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

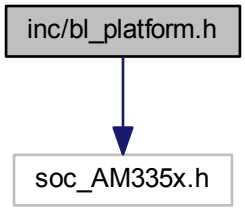


6.1.1 Detailed Description

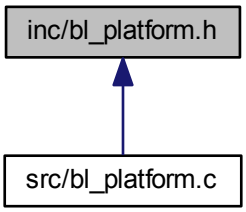
This file defines boot macros and objects.

6.2 inc/bl_platform.h File Reference

This file exports the APIs used for configuring devices required during boot.
`#include "soc_AM335x.h"`
Include dependency graph for bl_platform.h:



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



6.2.1 Detailed Description

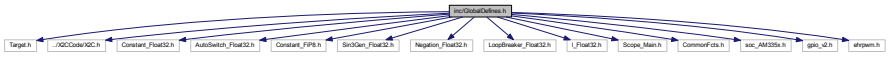
This file exports the APIs used for configuring devices required during boot.

6.3 inc/GlobalDefines.h File Reference

Collection of globally needed defines.

```
#include "Target.h"
#include "../X2CCode/X2C.h"
#include "soc_AM335x.h"
#include "gpio_v2.h"
#include "ehrpwm.h"
```

Include dependency graph for GlobalDefines.h:



Macros

- #define SELECTED_SAMPLETIME SAMPLETIME_100US
- #define PWM_FREQUENCY PWM_20KHZ /∗ fPWM = 20kHz ∗/

X2C Outports

- #define **USER_LED0** (∗Outports.pLED0) /∗ User LED 0 ∗/
- #define **USER_LED1** (∗Outports.pLED1) /∗ User LED 1 ∗/
- #define **USER_LED2** (∗Outports.pLED2) /∗ User LED 2 ∗/
- #define **USER_LED3** (∗Outports.pLED2) /∗ User LED 2 ∗/

X2C Inports

- #define **AIN0** (Inports.P9_39) /∗ Analog input 0 ∗/
- #define **AIN1** (Inports.P9_40) /∗ Analog input 1 ∗/
- #define **AIN2** (Inports.P9_37) /∗ Analog input 2 ∗/
- #define **AIN3** (Inports.P9_38) /∗ Analog input 3 ∗/
- #define **AIN4** (Inports.P9_33) /∗ Analog input 4 ∗/
- #define **AIN5** (Inports.P9_36) /∗ Analog input 5 ∗/
- #define **AIN6** (Inports.P9_35) /∗ Analog input 6 ∗/

Port Pin Definitions

- #define **USER_LED0_ON** GPIOPinWrite(SOC_GPIO_1_REGS, 21, GPIO_PIN_HIGH)
- #define **USER_LED0_OFF** GPIOPinWrite(SOC_GPIO_1_REGS, 21, GPIO_PIN_LOW)
- #define **USER_LED1_ON** GPIOPinWrite(SOC_GPIO_1_REGS, 22, GPIO_PIN_HIGH)
- #define **USER_LED1_OFF** GPIOPinWrite(SOC_GPIO_1_REGS, 22, GPIO_PIN_LOW)
- #define **USER_LED2_ON** GPIOPinWrite(SOC_GPIO_1_REGS, 23, GPIO_PIN_HIGH)
- #define **USER_LED2_OFF** GPIOPinWrite(SOC_GPIO_1_REGS, 23, GPIO_PIN_LOW)
- #define **USER_LED3_ON** GPIOPinWrite(SOC_GPIO_1_REGS, 24, GPIO_PIN_HIGH)
- #define **USER_LED3_OFF** GPIOPinWrite(SOC_GPIO_1_REGS, 24, GPIO_PIN_LOW)
- #define **GPIO_1_13_ON** GPIOPinWrite(SOC_GPIO_1_REGS, 13, GPIO_PIN_HIGH)
- #define **GPIO_1_13_OFF** GPIOPinWrite(SOC_GPIO_1_REGS, 13, GPIO_PIN_LOW)
- #define **GPIO_1_15_ON** GPIOPinWrite(SOC_GPIO_1_REGS, 15, GPIO_PIN_HIGH)
- #define **GPIO_1_15_OFF** GPIOPinWrite(SOC_GPIO_1_REGS, 15, GPIO_PIN_LOW)
- #define **GPIO_2_2_ON** GPIOPinWrite(SOC_GPIO_2_REGS, 2, GPIO_PIN_HIGH)
- #define **GPIO_2_2_OFF** GPIOPinWrite(SOC_GPIO_2_REGS, 2, GPIO_PIN_LOW)

- #define **GPIO_2_5_ON** GPIOPinWrite(SOC_GPIO_2_REGS, 5, GPIO_PIN_HIGH)
- #define **GPIO_2_5_OFF** GPIOPinWrite(SOC_GPIO_2_REGS, 5, GPIO_PIN_LOW)
- #define **READ_GPIO_1_12** GPIOPinRead(SOC_GPIO_1_REGS, 12)
- #define **READ_GPIO_1_14** GPIOPinRead(SOC_GPIO_1_REGS, 14)
- #define **READ_GPIO_2_3** GPIOPinRead(SOC_GPIO_2_REGS, 3)
- #define **READ_GPIO_2_4** GPIOPinRead(SOC_GPIO_2_REGS, 4)

6.3.1 Detailed Description

Collection of globally needed defines.
Available Preprocessor Definitions:

- none

6.3.2 Macro Definition Documentation

6.3.2.1 #define PWM_FREQUENCY PWM_20KHZ /∗ fPWM = 20kHz ∗/

PWM frequency

6.3.2.2 #define SELECTED_SAMPLETIME SAMPLETIME_100US

Sample time

6.4 inc/Hardware.h File Reference

Hardware initialization.

Functions

- void initHardware (void)
  Initialization of hardware.

6.4.1 Detailed Description

Hardware initialization.

6.4.2 Function Documentation

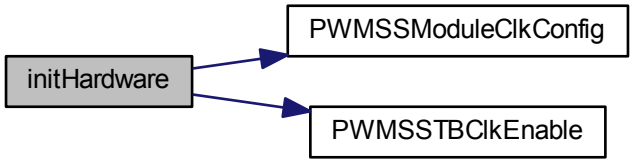
6.4.2.1 void initHardware (void)

Initialization of hardware.

- Configuration of IO ports
- Configuration of PWM
  - Activation of modules 0, 1, 2
  - Frequency set to 20kHz
  - Center aligned mode
  - Active high complementary output mode
  - Dead band module activated, but delay is set to 0 by default
- Configuration of ADC
  - Activation of channels 0..6

  - 200kSamples/s
  - ADC is triggered by timer 4
- Configuration of timer 4
  - 24MHz timer clock
  - Generation of cyclic interrupt with selected sample time
  - Interrupt calls X2C main task

Here is the call graph for this function:



6.5 inc/InputControl.h File Reference

Handling of inputs.

Functions

- void readAnalogIn (void)

  Routine to read values from ADC.
- void readDigitalIn (void)

  Routine to read digital input pins.

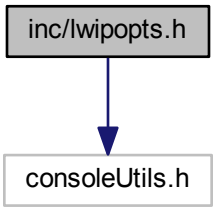
6.5.1 Detailed Description

Handling of inputs.

- Reading of digital inputs
- Reading of analog inputs

6.6 inc/lwipopts.h File Reference

`#include "consoleUtils.h"`
Include dependency graph for lwipopts.h:



Macros

- #define LWIP_NETIF_HOSTNAME 1

6.6.1 Detailed Description

- Configuration options for lwIP

Copyright (c) 2010 Texas Instruments Incorporated

6.6.2 Macro Definition Documentation

6.6.2.1 #define LWIP_NETIF_HOSTNAME 1

User specific macros.

6.7 inc/Main.h File Reference

Main function.

Functions

- void mainTask (void)

  Main control task.

6.7.1 Detailed Description

Main function.
X2C maintenance table, protocol & hardware initialization.
Uses Atmel Software Framework (ASF).

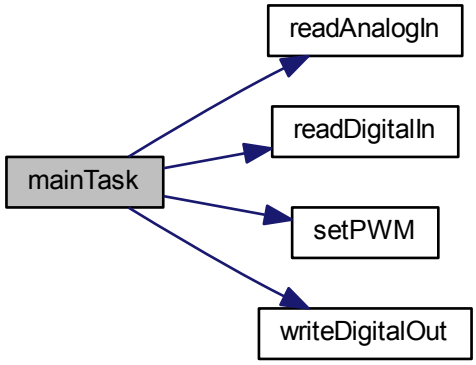
6.7.2 Function Documentation

6.7.2.1 void mainTask (void)

Main control task.
This task is/has to be called periodically. Calling rate = Sample time defined in GlobalDefines.h

- assign inports
- update X2C
- update outports

Here is the call graph for this function:



6.8 inc/MMUConfig.h File Reference

MMU configuration.

6.8.1 Detailed Description

MMU configuration.

6.9 inc/OutputControl.h File Reference

Handling of outputs.

Functions

- void setPWM (void)

  Routine to set PWM duty cycle.
- void writeDigitalOut (void)

  Routine to write to digital output pins.

6.9.1 Detailed Description

Handling of outputs.

- Setting duty cycle of PWM signals
- Setting of digital outputs

6.9.2 Function Documentation

6.9.2.1 void setPWM (void)

Routine to set PWM duty cycle.

- check range of duty cycle
- set duty cycle in PWM module

6.9.2.2 void writeDigitalOut (void)

Routine to write to digital output pins.

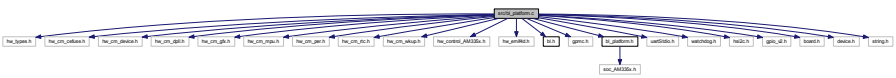
- LEDs
- General purpose outputs

6.10 src/bl_platform.c File Reference

Initializes AM335x Device Peripherals.

```
#include "hw_types.h"
#include "hw_cm_cefuse.h"
#include "hw_cm_device.h"
#include "hw_cm_dpll.h"
#include "hw_cm_gfx.h"
#include "hw_cm_mpu.h"
#include "hw_cm_per.h"
#include "hw_cm_rtc.h"
#include "hw_cm_wkup.h"
#include "hw_control_AM335x.h"
#include "hw_emif4d.h"
#include "bl.h"
#include "gpmc.h"
#include "bl_platform.h"
#include "uartStdio.h"
#include "watchdog.h"
#include "hsi2c.h"
#include "gpio_v2.h"
#include "board.h"
#include "device.h"
#include "string.h"
```

Include dependency graph for bl_platform.c:



Functions

- void ConfigureVdd2 (unsigned int opVolMultiplier, unsigned maxLoadCurrent, unsigned int timeStep, unsigned int supplyState)
  - *Configure vdd2 for various parameters such as Multiplier, Maximum Load Current etc .*

- void SelectVdd2Source (unsigned int vddSource)

  Select the VDD2 value. VDD2_OP_REG or VDD2_SR_REG.
- void SetVdd2OpVoltage (unsigned int opVolSelector)

  set VDD2_OP voltage value.
- void SetVdd2SrVoltage (unsigned int opVolSelector)

  set VDD2_SR voltage value
- void SelectI2CInstance (unsigned int i2cInstance)

  Select I2C interface whether SR I2C or Control I2C.
- void ConfigureVdd1 (unsigned int opVolMultiplier, unsigned maxLoadCurrent, unsigned int timeStep, unsigned int supplyState)
  - *Configure vdd1 for various parameters such as Multiplier, Maximum Load Current etc .*
- void SelectVdd1Source (unsigned int vddSource)

  Select the VDD1 value. VDD1_OP_REG or VDD1_SR_REG.
- void SetVdd1OpVoltage (unsigned int opVolSelector)

  set VDD1_OP voltage value.

6.10.1 Detailed Description

Initializes AM335x Device Peripherals.

6.10.2 Function Documentation

6.10.2.1 void ConfigureVdd1 (unsigned int *opVolMultiplier,* unsigned *maxLoadCurrent,* unsigned int *timeStep,* unsigned int *supplyState*)

- Configure vdd1 for various parameters such as Multiplier, Maximum Load Current etc .

Parameters

opVolMultiplier	- Multiplier.
maxLoadCurrent	- Maximum Load Current.
timeStep	- Time step - voltage change per us(micro sec).
supplyState	- Supply state (on (high/low power mode), off)

Returns

: None.

6.10.2.2 void ConfigureVdd2 (unsigned int *opVolMultiplier,* unsigned *maxLoadCurrent,* unsigned int *timeStep,* unsigned int *supplyState*)

- Configure vdd2 for various parameters such as Multiplier, Maximum Load Current etc .

Parameters

opVolMultiplier	- Multiplier.
maxLoadCurrent	- Maximum Load Current.
timeStep	- Time step - voltage change per us(micro sec).
supplyState	- Supply state (on (high/low power mode), off)

Returns

: None.

6.10.2.3 void SelectI2CInstance (unsigned int *i2cInstance*)

Select I2C interface whether SR I2C or Control I2C.
Parameters

i2cInstance	- I2c instance to select.

Returns

None.

6.10.2.4 void SelectVdd1Source (unsigned int *vddSource*)

Select the VDD1 value. VDD1_OP_REG or VDD1_SR_REG.
Parameters

vddSource	- VDD2 value.

Returns

None.

6.10.2.5 void SelectVdd2Source (unsigned int *vddSource*)

Select the VDD2 value. VDD2_OP_REG or VDD2_SR_REG.
Parameters

vddSource	- VDD2 value.

Returns

None.

6.10.2.6 void SetVdd1OpVoltage (unsigned int *opVolSelector*)

set VDD1_OP voltage value.

Parameters

opVolSelector	- VDD2_OP voltage value.

Returns

None.

6.10.2.7 void SetVdd2OpVoltage (unsigned int *opVolSelector*)

set VDD2_OP voltage value.

Parameters

opVolSelector	- VDD2_OP voltage value.

Returns

None.

6.10.2.8 void SetVdd2SrVoltage (unsigned int *opVolSelector*)

set VDD2_SR voltage value

Parameters

opVolSelector	- VDD2_SR voltage value.

Returns

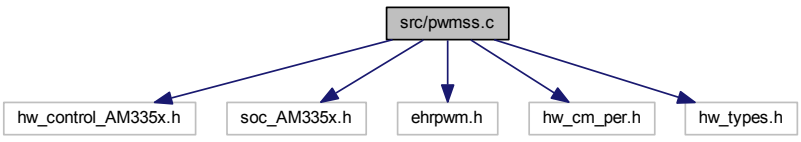
None.

6.11 src/pwmss.c File Reference

This file contains functions which does platform specific configurations for PWMSS.

```
#include "hw_control_AM335x.h"
#include "soc_AM335x.h"
#include "ehrpwm.h"
#include "hw_cm_per.h"
#include "hw_types.h"
```

Include dependency graph for pwmss.c:



Functions

- void PWMSSTBClkEnable (unsigned int instance)

  This function Enables TBCLK(Time Base Clock) for specific EPWM instance of pwmsubsystem.
- void PWMSSModuleClkConfig (unsigned int instanceNum)

  This function configures the L3 and L4_PER system clocks. It also configures the system clocks for the specified ePWMSS instance.

6.11.1 Detailed Description

This file contains functions which does platform specific configurations for PWMSS.

6.11.2 Function Documentation

6.11.2.1 void PWMSSModuleClkConfig (unsigned int *instanceNum*)

This function configures the L3 and L4_PER system clocks. It also configures the system clocks for the specified ePWMSS instance.

Parameters

instanceNum	The instance number of ePWMSS whose system clocks have to be configured.

'instanceNum' can take one of the following values: (0 <= instanceNum <= 2)

Returns

None.

6.11.2.2 void PWMSSTBClkEnable (unsigned int *instance*)

This function Enables TBCLK(Time Base Clock) for specific EPWM instance of pwmsubsystem.

Parameters

instance	It is the instance number of EPWM of pwmsubsystem.

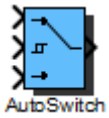
Part III

Used X2C-Blocks

7 Project Specific Blocks

8 Internal Library Blocks

Block: AutoSwitch



Inports	
In1	Input #1
Switch	Input #2: Threshold signal
In3	Input #3

Outports	
Out	Either value of input #1 or input #3 dependent on value of input #2

Mask Parameters	
Thresh_up	Threshold level for rising switch signal
Thresh_down	Threshold level for falling switch signal

Description:

Switch between In1 and In3 dependent on Switch signal:
Switch signal rising: Switch >= Threshold up –> Out = In1
Switch signal falling: Switch < Threshold down –> Out = In3

Implementations:

FiP8	8 Bit Fixed Point Implementation
FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation

Implementation: FiP8

Name	FiP8
ID	128
Revision	0.1
C filename	AutoSwitch_FiP8.c
H filename	AutoSwitch_FiP8.h

8 Bit Fixed Point Implementation

Controller Parameters	
Thresh_up	Threshold level for rising switch signal
Thresh_down	Threshold level for falling switch signal
Status	Current hysteresis state

Data Structure:

```
typedef struct {
      uint16          ID;
      int8            *In1;
      int8            *Switch;
      int8            *In3;
      int8            Out;
      int8            Thresh_up;
      int8            Thresh_down;
      int8            Status;
} AUTOSWITCH_FIP8;
```

Implementation: FiP16

Name	FiP16
ID	129
Revision	0.1
C filename	AutoSwitch_FiP16.c
H filename	AutoSwitch_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
Thresh_up	Threshold level for rising switch signal
Thresh_down	Threshold level for falling switch signal
Status	Current hysteresis state

Data Structure:

```
typedef struct {
      uint16          ID;
      int16           *In1;
      int16           *Switch;
      int16           *In3;
```

```
    int16           Out;
    int16           Thresh_up;
    int16           Thresh_down;
    int8            Status;
} AUTOSWITCH_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	130
Revision	0.1
C filename	AutoSwitch_FiP32.c
H filename	AutoSwitch_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
Thresh_up	Threshold level for rising switch signal
Thresh_down	Threshold level for falling switch signal
Status	Current hysteresis state

Data Structure:

```
typedef struct {
    uint16          ID;
    int32           *In1;
    int32           *Switch;
    int32           *In3;
    int32           Out;
    int32           Thresh_up;
    int32           Thresh_down;
    int8            Status;
} AUTOSWITCH_FIP32;
```

Implementation: Float32

Name	Float32
ID	131
Revision	0.1
C filename	AutoSwitch_Float32.c
H filename	AutoSwitch_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
Thresh_up	Threshold level for rising switch signal
Thresh_down	Threshold level for falling switch signal
Status	Current hysteresis state

Data Structure:

```
typedef struct {
      uint16          ID;
      float32         *In1;
      float32         *Switch;
      float32         *In3;
      float32         Out;
      float32         Thresh_up;
      float32         Thresh_down;
      int8            Status;
} AUTOSWITCH_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	132
Revision	0.1
C filename	AutoSwitch_Float64.c
H filename	AutoSwitch_Float64.h

64 Bit Floating Point Implementation

Controller Parameters	
Thresh_up	Threshold level for rising switch signal
Thresh_down	Threshold level for falling switch signal
Status	Current hysteresis state

Data Structure:

```
typedef struct {
      uint16          ID;
      float64         *In1;
      float64         *Switch;
      float64         *In3;
      float64         Out;
      float64         Thresh_up;
      float64         Thresh_down;
      int8            Status;
} AUTOSWITCH_FLOAT64;
```

Block: Constant

Outports	
Out	Constant output

Mask Parameters	
Value	Constant factor

Description:

Constant value.

Implementations:

FiP8	8 Bit Fixed Point Implementation
FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation

Implementation: FiP8

Name	FiP8
ID	48
Revision	0.3
C filename	Constant_FiP8.c
H filename	Constant_FiP8.h

8 Bit Fixed Point Implementation

Controller Parameters	
K	Constant factor

Data Structure:

```
typedef struct {
      uint16          ID;
      int8            Out;
      int8            K;
} CONSTANT_FIP8;
```

Implementation: FiP16

Name	FiP16
ID	49
Revision	0.3
C filename	Constant_FiP16.c
H filename	Constant_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
K	Constant factor

Data Structure:

```
typedef struct {
      uint16          ID;
      int16           Out;
      int16           K;
} CONSTANT_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	50
Revision	0.3
C filename	Constant_FiP32.c
H filename	Constant_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
K	Constant factor

Data Structure:

```
typedef struct {
      uint16          ID;
      int32           Out;
      int32           K;
} CONSTANT_FIP32;
```

Implementation: Float32

Name	Float32
ID	51
Revision	0.1
C filename	Constant_Float32.c
H filename	Constant_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
K	Constant factor

Data Structure:

```
typedef struct {
      uint16          ID;
      float32         Out;
      float32         K;
} CONSTANT_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	52
Revision	0.1
C filename	Constant_Float64.c
H filename	Constant_Float64.h

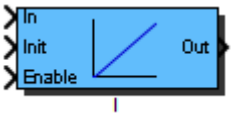
64 Bit Floating Point Implementation

Controller Parameters	
K	Constant factor

Data Structure:

```
typedef struct {
      uint16          ID;
      float64         Out;
      float64         K;
} CONSTANT_FLOAT64;
```

Block: I



Inports	
In	Control error input
Init	Value which is loaded at initialization function call
Enable	Enable == 0: Deactivation of block; Out set to 0 Enable 0->1: Preload of integral part Enable == 1: Activation of block

Outports	
Out	Control value

Mask Parameters	
Ki	Integral Factor
ts_fact	Multiplication factor of base sampling time (in integer format)

Description:

I controller:
G(s) = Ki/s = 1/(Ti*s)

Each fixed point implementation uses the next higher integer datatype for the integrational value storage variable.
A rising flank at the *Enable* inport will preload the integrational part with the value present on the *Init* inport.

Transfer function (zero-order hold discretization method):

$$G(z) = K_I T_s \frac{1}{z-1}$$

Implementations:

FiP8	8 Bit Fixed Point Implementation
FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation

Implementation: FiP8

Name FiP8
ID 3200
Revision 1.0
C filename I_FiP8.c
H filename I_FiP8.h

8 Bit Fixed Point Implementation

Controller Parameters	
b0	Integral coefficient
sfr	Shift factor for I coefficient b0
i_old	Integrator value from previous cycle
enable_old	Enable value of previous cycle

Data Structure:

```
typedef struct {
      uint16          ID;
      int8            *In;
      int8            *Init;
      int8            *Enable;
      int8            Out;
      int8            b0;
      int8            sfr;
      int16           i_old;
      int8            enable_old;
} I_FIP8;
```

Implementation: FiP16

Name FiP16
ID 3201
Revision 1.0
C filename I_FiP16.c
H filename I_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
b0	Integral coefficient
sfr	Shift factor for I coefficient b0
i_old	Integrator value from previous cycle
enable_old	Enable value of previous cycle

Data Structure:

```
typedef struct {
```

```
    uint16          ID;
    int16           *In;
    int16           *Init;
    int8            *Enable;
    int16           Out;
    int16           b0;
    int8            sfr;
    int32           i_old;
    int8            enable_old;
} I_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	3202
Revision	1.0
C filename	I_FiP32.c
H filename	I_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
b0	Integral coefficient
sfr	Shift factor for I coefficient b0
i_old	Integrator value from previous cycle
enable_old	Enable value of previous cycle

Data Structure:

```
typedef struct {
    uint16          ID;
    int32           *In;
    int32           *Init;
    int8            *Enable;
    int32           Out;
    int32           b0;
    int8            sfr;
    int64           i_old;
    int8            enable_old;
} I_FIP32;
```

Implementation: Float32

Name	Float32
ID	3203
Revision	0.1
C filename	I_Float32.c
H filename	I_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
b0	Integral coefficient
i_old	Integrator value from previous cycle
enable_old	Enable value of previous cycle

Data Structure:

```
typedef struct {
      uint16          ID;
      float32         *In;
      float32         *Init;
      int8            *Enable;
      float32         Out;
      float32         b0;
      float32         i_old;
      int8            enable_old;
} I_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	3204
Revision	0.1
C filename	I_Float64.c
H filename	I_Float64.h

64 Bit Floating Point Implementation

Controller Parameters	
b0	Integral coefficient
i_old	Integrator value from previous cycle
enable_old	Enable value of previous cycle

Data Structure:

```
typedef struct {
      uint16          ID;
      float64         *In;
      float64         *Init;
      int8            *Enable;
      float64         Out;
      float64         b0;
      float64         i_old;
      int8            enable_old;
} I_FLOAT64;
```

Block: LoopBreaker

Inports	
In	Input In(k)

Outports	
Out	Output Out(k)=In(k-1)

Description:

Block to break algebraic loops.

Implementations:

FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation

Implementation: FiP16

Name	FiP16
ID	481
Revision	0.1
C filename	LoopBreaker_FiP16.c
H filename	LoopBreaker_FiP16.h

16 Bit Fixed Point Implementation

Data Structure:

```
typedef struct {
     uint16          ID;
     int16           *In;
     int16           Out;
} LOOPBREAKER_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	482
Revision	0.1
C filename	LoopBreaker_FiP32.c
H filename	LoopBreaker_FiP32.h

32 Bit Fixed Point Implementation

Data Structure:

```
typedef struct {
      uint16          ID;
      int32           *In;
      int32           Out;
} LOOPBREAKER_FIP32;
```

Implementation: Float32

Name	Float32
ID	483
Revision	0.1
C filename	LoopBreaker_Float32.c
H filename	LoopBreaker_Float32.h

32 Bit Floating Point Implementation

Data Structure:

```
typedef struct {
      uint16          ID;
      float32         *In;
      float32         Out;
} LOOPBREAKER_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	484
Revision	0.1
C filename	LoopBreaker_Float64.c
H filename	LoopBreaker_Float64.h

64 Bit Floating Point Implementation

Data Structure:

```
typedef struct {
      uint16          ID;
      float64         *In;
      float64         Out;
} LOOPBREAKER_FLOAT64;
```

Block: Negation

Inports	
In	Input

Outports	
Out	Negated input value

Description:

Negation of input signal.

Calculation:

$$Out = -In$$

Implementations:

FiP8	8 Bit Fixed Point Implementation
FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation

Implementation: FiP8

Name	FiP8
ID	5040
Revision	0.1
C filename	Negation_FiP8.c
H filename	Negation_FiP8.h

8 Bit Fixed Point Implementation

Data Structure:

```
typedef struct {
    uint16          ID;
    int8            *In;
    int8            Out;
} NEGATION_FIP8;
```

Implementation: FiP16

Name	FiP16
ID	5041
Revision	0.1
C filename	Negation_FiP16.c
H filename	Negation_FiP16.h

16 Bit Fixed Point Implementation

Data Structure:

```
typedef struct {
    uint16          ID;
    int16           *In;
    int16           Out;
} NEGATION_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	5042
Revision	0.1
C filename	Negation_FiP32.c
H filename	Negation_FiP32.h

32 Bit Fixed Point Implementation

Data Structure:

```
typedef struct {
    uint16          ID;
    int32           *In;
    int32           Out;
} NEGATION_FIP32;
```

Implementation: Float32

Name	Float32
ID	5043
Revision	0.1
C filename	Negation_Float32.c
H filename	Negation_Float32.h

32 Bit Floating Point Implementation

Data Structure:

```
typedef struct {
    uint16          ID;
    float32         *In;
    float32         Out;
```

```
} NEGATION_FLOAT32;
```

Implementation: Float64

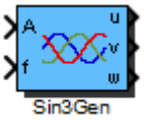
Name	Float64
ID	5044
Revision	0.1
C filename	Negation_Float64.c
H filename	Negation_Float64.h

64 Bit Floating Point Implementation

Data Structure:

```
typedef struct {
    uint16          ID;
    float64         *In;
    float64         Out;
} NEGATION_FLOAT64;
```

Block: Sin3Gen



Inports	
A	Amplitude
f	Frequency

Outports	
u	Sine wave output phase u
v	Sine wave output phase v
w	Sine wave output phase w

Mask Parameters	
fmax	Maximum Frequency in Hz
Offset	Offset
ts_fact	Multiplication factor of base sampling time (in integer format)

Description:

Generation of a 3 sine waves with amplitude (A) and frequency (f).

Calculation fixed point implementation:

$$\begin{aligned} u_k &= A_k \cdot \sin\left(2 f_k \cdot f_{max} \cdot k T_S\right) + A_{Offset} \\ v_k &= A_k \cdot \sin\left(2 f_k \cdot f_{max} \cdot k T_S - \frac{2\pi}{3}\right) + A_{Offset} \\ w_k &= A_k \cdot \sin\left(2 f_k \cdot f_{max} \cdot k T_S + \frac{2\pi}{3}\right) + A_{Offset} \end{aligned}$$

For sine calculation a lookup table with 256 entries is used. This results in a short computation time but with the downside of reduced accuracy for the FiP32 implementation.

Calculation floating point implementation (parameter *f_max* is ignored):

$$\begin{aligned} u_k &= A_k \cdot \sin\left(2\pi f_k \cdot k T_S\right) + A_{Offset} \\ v_k &= A_k \cdot \sin\left(2\pi f_k \cdot k T_S - \frac{2\pi}{3}\right) + A_{Offset} \\ w_k &= A_k \cdot \sin\left(2\pi f_k \cdot k T_S + \frac{2\pi}{3}\right) + A_{Offset} \end{aligned}$$

Implementations:

FiP8	8 Bit Fixed Point Implementation
FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation

Implementation: FiP8

Name	FiP8
ID	432
Revision	1.0
C filename	Sin3Gen_FiP8.c
H filename	Sin3Gen_FiP8.h

8 Bit Fixed Point Implementation

Controller Parameters	
delta_phi	Angle increment
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
     uint16          ID;
     int8            *A;
     int8            *f;
     int8            u;
     int8            v;
     int8            w;
     int8            delta_phi;
     int8            offset;
     int8            phi;
} SIN3GEN_FIP8;
```

Implementation: FiP16

Name	FiP16
ID	433
Revision	1.0
C filename	Sin3Gen_FiP16.c
H filename	Sin3Gen_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
delta_phi	Angle increment
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      int16           *A;
      int16           *f;
      int16           u;
      int16           v;
      int16           w;
      int16           delta_phi;
      int16           offset;
      int16           phi;
} SIN3GEN_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	434
Revision	1.0
C filename	Sin3Gen_FiP32.c
H filename	Sin3Gen_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
delta_phi	Angle increment
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      int32           *A;
      int32           *f;
      int32           u;
      int32           v;
      int32           w;
      int32           delta_phi;
      int32           offset;
      int32           phi;
} SIN3GEN_FIP32;
```

Implementation: Float32

Name Float32
ID 435
Revision 0.1
C filename Sin3Gen_Float32.c
H filename Sin3Gen_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
delta_phi	Angle increment
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
    uint16      ID;
    float32     *A;
    float32     *f;
    float32     u;
    float32     v;
    float32     w;
    float32     delta_phi;
    float32     offset;
    float32     phi;
} SIN3GEN_FLOAT32;
```

Implementation: Float64

Name Float64
ID 436
Revision 0.1
C filename Sin3Gen_Float64.c
H filename Sin3Gen_Float64.h

64 Bit Floating Point Implementation

Controller Parameters	
delta_phi	Angle increment
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
    uint16      ID;
    float64     *A;
    float64     *f;
```

```
    float64         u;
    float64         v;
    float64         w;
    float64         delta_phi;
    float64         offset;
    float64         phi;
} SIN3GEN_FLOAT64;
```