LINZ CENTER OF MECHATRONICS GMBH

Project Documentation DemoApplication

December 23, 2016

Contents

Part I

X2C Model

1 Version Information

1.1 X2C

- X2Cfull: Version 1068

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

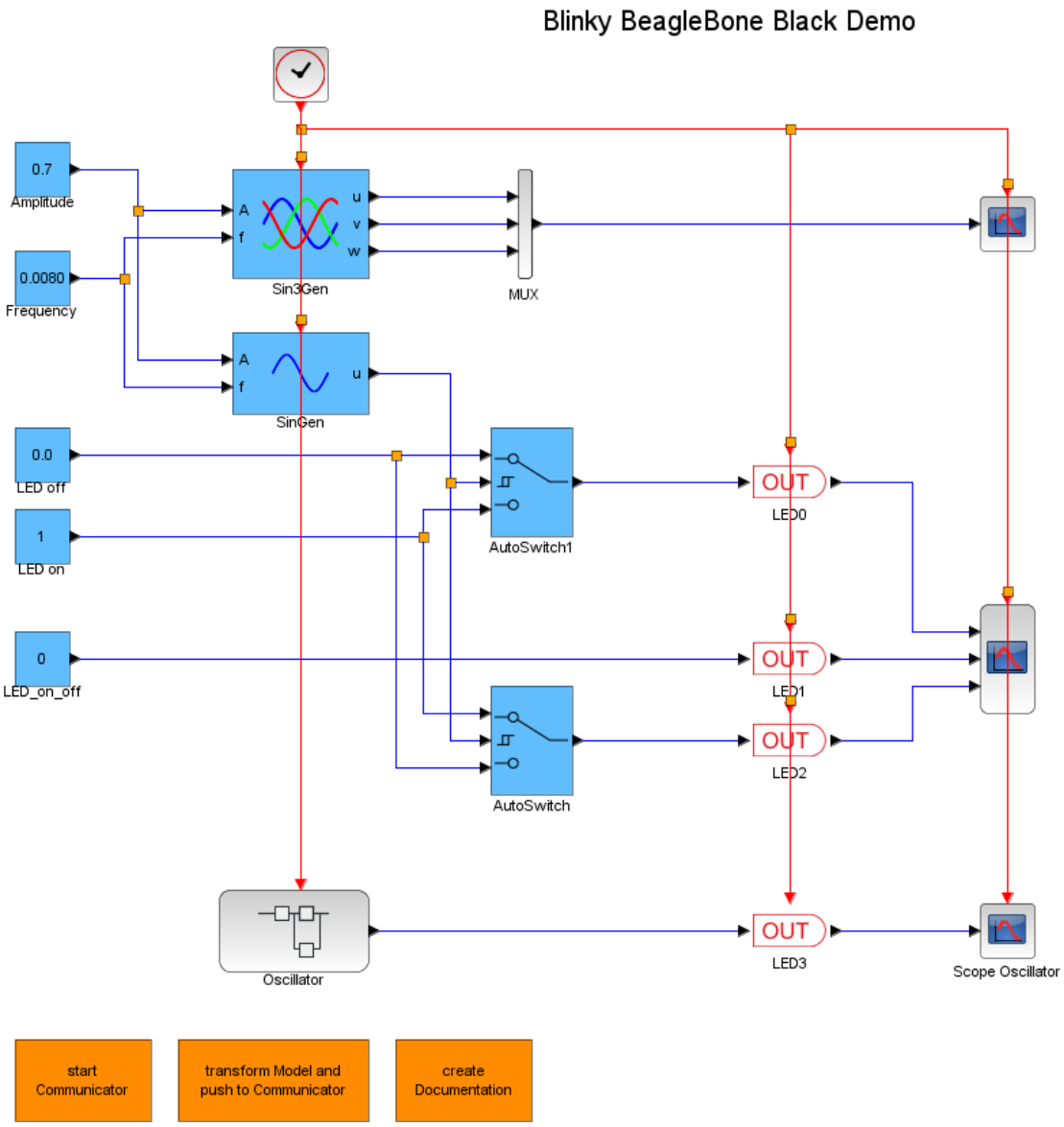

Figure 1: DemoApplication

2.2 Subsystems

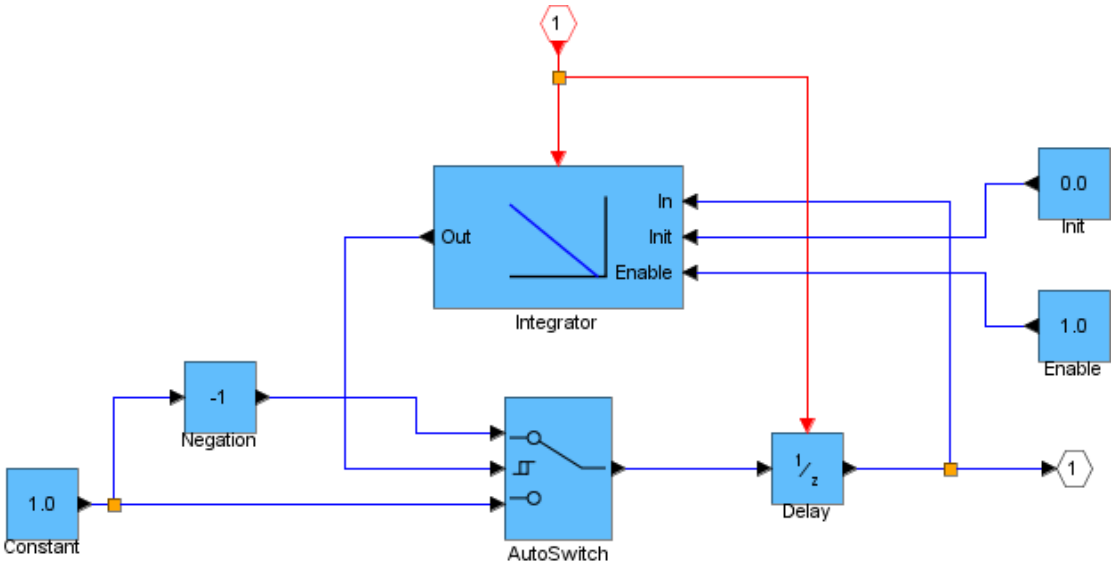

Figure 2: DemoApplication_Oscillator

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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// SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
//
// $LastChangedRevision: 844 $
// $LastChangedDate:: 2016-09-01 15:18:35 +0200#$
//
// 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	0.7
Used Implementation	FiP16

AutoSwitch: AutoSwitch	
Thresh_up	0.6
Thresh_down	0.4
Used Implementation	FiP16

AutoSwitch: AutoSwitch1	
Thresh_up	0.0
Thresh_down	0.0
Used Implementation	FiP16

Constant: Frequency	
Value	0.0080
Used Implementation	FiP16

Constant: LED off	
Value	0.0
Used Implementation	FiP16

Constant: LED on	
Value	1.0
Used Implementation	FiP16

Constant: LED_on_off	
Value	0.0
Used Implementation	FiP16

AutoSwitch: Oscillator__AutoSwitch	
Thresh_up	0.5
Thresh_down	-0.5
Used Implementation	FiP16

Constant: Oscillator__Constant	
Value	1.0
Used Implementation	FiP16

Delay: Oscillator__Delay	
ts_fact	1.0
Used Implementation	FiP16

Constant: Oscillator__Enable	
Value	1.0
Used Implementation	FiP8

Constant: Oscillator__Init	
Value	0.0
Used Implementation	FiP16

I: Oscillator__Integrator	
Ki	25.0
ts_fact	1.0
Used Implementation	FiP16

Negation: Oscillator__Negation	
Used Implementation	FiP16

Sin3Gen: Sin3Gen	
fmax	1000.0
Offset	0.0
ts_fact	1.0
Used Implementation	FiP16

SinGen: SinGen	
fmax	1000.0
Offset	0.0
Phase	0.0
ts_fact	1.0
Used Implementation	FiP16

Part II
User Specific Documentation

Feel free to add your documentation here!

Part III

Hardware Documentation

Part IV
Frame Program Documentation

5 File Index

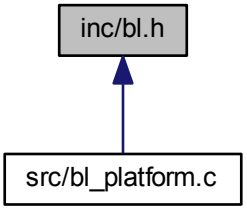
5.1 File List

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

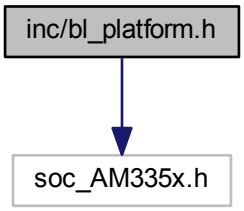
This file defines boot macros and objects.

6.2 inc/bl_platform.h File Reference

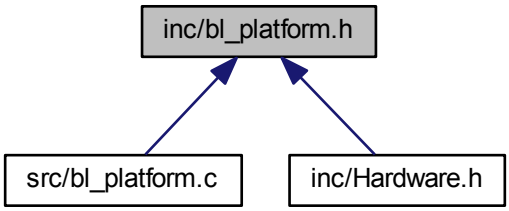
This file exports the APIs used for configuring devices required during boot.

```
#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

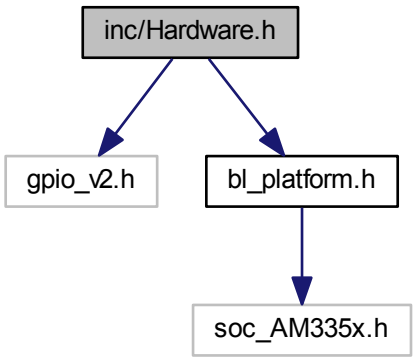
This file exports the APIs used for configuring devices required during boot.

6.3 inc/Hardware.h File Reference

Hardware initialization.

```
#include "gpio_v2.h"
#include "bl_platform.h"
```

Include dependency graph for Hardware.h:



Functions

- void initHardware (void)

  Initialization of hardware.

6.3.1 Detailed Description

Hardware initialization.

6.3.2 Function Documentation

6.3.2.1 void initHardware (void)

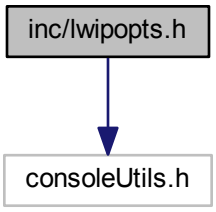
Initialization of hardware.

- Configuration of IO ports
- Configuration of timer 2
  - 24MHz timer clock
  - Generation of cyclic interrupt with selected sample time
  - Interrupt calls X2C main task

6.4 inc/lwipopts.h File Reference

```
#include "consoleUtils.h"
```

Include dependency graph for lwipopts.h:



Macros

- #define LWIP_NETIF_HOSTNAME 1

6.4.1 Detailed Description

- Configuration options for lwIP

Copyright (c) 2010 Texas Instruments Incorporated

6.4.2 Macro Definition Documentation

6.4.2.1 #define LWIP_NETIF_HOSTNAME 1

User specific macros.

6.5 inc/Main.h File Reference

Main function.

Functions

- void mainTask (void)

  Main control task.

6.5.1 Detailed Description

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

6.5.2 Function Documentation

6.5.2.1 void mainTask (void)

Main control task.
TODO: This task has to be called periodically. Calling rate = 100us

- assign inports (not available in this demo)
- update X2C
- update outports

6.6 inc/MMUConfig.h File Reference

MMU configuration.

6.6.1 Detailed Description

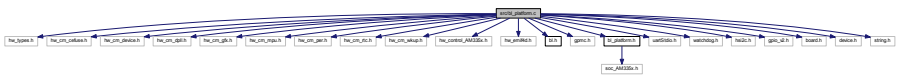
MMU configuration.

6.7 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.

6.7.1 Detailed Description

Initializes AM335x Device Peripherals.

6.7.2 Function Documentation

6.7.2.1 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.

6.7.2.2 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.

6.7.2.3 void SelectI2CInstance (unsigned int *i2cInstance*)

Select I2C interface whether SR I2C or Control I2C.

Parameters

i2cInstance	- I2c instance to select.

Returns

None.

6.7.2.4 void SelectVdd1Source (unsigned int *vddSource*)

Select the VDD1 value. VDD1_OP_REG or VDD1_SR_REG.

Parameters

vddSource	- VDD2 value.

Returns

None.

6.7.2.5 void SelectVdd2Source (unsigned int *vddSource*)

Select the VDD2 value. VDD2_OP_REG or VDD2_SR_REG.

Parameters

vddSource	- VDD2 value.

Returns

None.

6.7.2.6 void SetVdd1OpVoltage (unsigned int *opVolSelector*)

set VDD1_OP voltage value.

Parameters

opVolSelector	- VDD2_OP voltage value.

Returns

None.

6.7.2.7 void SetVdd2OpVoltage (unsigned int *opVolSelector*)

set VDD2_OP voltage value.

Parameters

opVolSelector	- VDD2_OP voltage value.

Returns

None.

6.7.2.8 void SetVdd2SrVoltage (unsigned int *opVolSelector*)

set VDD2_SR voltage value

Parameters

opVolSelector	- VDD2_SR voltage value.

Returns

None.

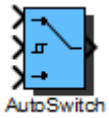
Part V

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: Delay

Inports	
In	Input In(k)

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

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

Description:

Output delay by one sample time interval.

This block can be used to enable feedback loops in the model.

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	3425
Revision	0.1
C filename	Delay_FiP16.c
H filename	Delay_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
In_old	Input value from previous cycle

Data Structure:

```
typedef struct {
    uint16        ID;
```

```
    int16           *In;
    int16           Out;
    int16           In_old;
} DELAY_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	3426
Revision	0.1
C filename	Delay_FiP32.c
H filename	Delay_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
In_old	Input value from previous cycle

Data Structure:

```
typedef struct {
    uint16          ID;
    int32           *In;
    int32           Out;
    int32           In_old;
} DELAY_FIP32;
```

Implementation: Float32

Name	Float32
ID	3427
Revision	0.1
C filename	Delay_Float32.c
H filename	Delay_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
In_old	Input value from previous cycle

Data Structure:

```
typedef struct {
    uint16          ID;
    float32         *In;
    float32         Out;
    float32         In_old;
} DELAY_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	3428
Revision	0.1
C filename	Delay_Float64.c
H filename	Delay_Float64.h

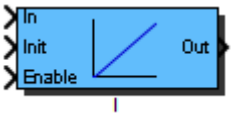
64 Bit Floating Point Implementation

Controller Parameters	
In_old	Input value from previous cycle

Data Structure:

```
typedef struct {
      uint16          ID;
      float64         *In;
      float64         Out;
      float64         In_old;
} DELAY_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: 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

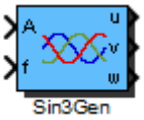
Name	Float64
ID	5044
Revision	0.1
C filename	Negation_Float64.c
H filename	Negation_Float64.h

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:

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

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):

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

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

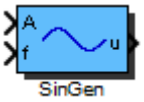
Controller Parameters	
delta_phi	Angle increment
offset	Amplitude offset
phi	Current angle

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;
```

Block: SinGen



Inports	
A	Amplitude
f	Frequency

Outports	
u	Sine wave output

Mask Parameters	
fmax	Maximum Frequency in Hz
Offset	Offset
Phase	Phase [-Pi..Pi]
ts_fact	Multiplication factor of base sampling time (in integer format)

Description:

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

Calculation fixed point implementation:

$$u_k = A_k \cdot \sin\left(2 f_k \cdot f_{max} \cdot k T_S + \phi_{Phase}\right) + A_{Offset}$$

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):

$$u_k = A_k \cdot \sin\left(2\pi f_k \cdot k T_S + \phi_{Phase}\right) + A_{Offset}$$

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 416
Revision 1.0
C filename SinGen_FiP8.c
H filename SinGen_FiP8.h

8 Bit Fixed Point Implementation

Controller Parameters	
delta_phi	Angle increment
phase	Angle offset
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      int8            *A;
      int8            *f;
      int8            u;
      int8            delta_phi;
      int8            phase;
      int8            offset;
      int8            phi;
} SINGEN_FIP8;
```

Implementation: FiP16

Name FiP16
ID 417
Revision 1.0
C filename SinGen_FiP16.c
H filename SinGen_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
delta_phi	Angle increment
phase	Angle offset
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      int16           *A;
      int16           *f;
```

```
    int16           u;
    int16           delta_phi;
    int16           phase;
    int16           offset;
    int16           phi;
} SINGEN_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	418
Revision	1.0
C filename	SinGen_FiP32.c
H filename	SinGen_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
delta_phi	Angle increment
phase	Angle offset
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
    uint16          ID;
    int32           *A;
    int32           *f;
    int32           u;
    int32           delta_phi;
    int32           phase;
    int32           offset;
    int32           phi;
} SINGEN_FIP32;
```

Implementation: Float32

Name	Float32
ID	419
Revision	0.1
C filename	SinGen_Float32.c
H filename	SinGen_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
delta_phi	Angle increment
phase	Angle offset
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      float32         *A;
      float32         *f;
      float32         u;
      float32         delta_phi;
      float32         phase;
      float32         offset;
      float32         phi;
} SINGEN_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	420
Revision	0.1
C filename	SinGen_Float64.c
H filename	SinGen_Float64.h

64 Bit Floating Point Implementation

Controller Parameters	
delta_phi	Angle increment
phase	Angle offset
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      float64         *A;
      float64         *f;
      float64         u;
      float64         delta_phi;
      float64         phase;
      float64         offset;
      float64         phi;
} SINGEN_FLOAT64;
```